

# SUB WAYS

**is a personal account** of the grand human experiment so many teachers could write but so few do. I do this from the lowly but unencumbered position as a substitute teacher backed by my perspective as a professor and scientist. I give my thoughts, feelings, prejudices, and biases about teaching and learning as one example of the human package that accompanies each teacher. I take you into the classroom to give you a flavor of what it is like to be a teacher and what it is like to be a student – how challenging and rewarding.

**If your school days are behind you**, this may help you better remember, so as to understand the good and bad, and make more sense of where you spent so much of your life.

**If you are a student**, this may help you to appreciate your struggles and give them more meaning, and to empathize with your overlords, the teachers, by showing you their humanity and sincerity. In short, it may ease the years that you are forced to spend so much of your time and even make them a bit more enjoyable.

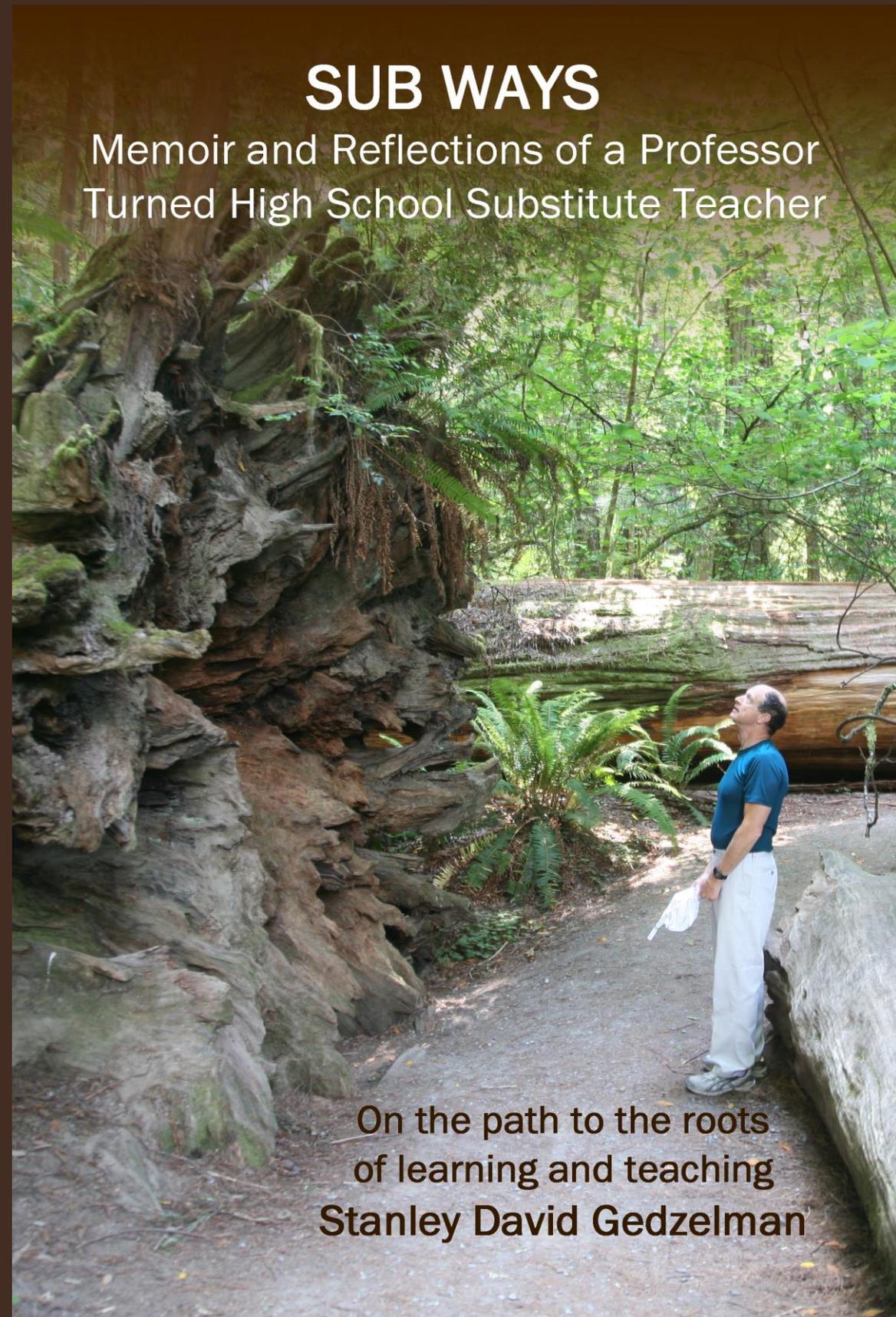
**If you are a teacher**, this may remind you that you are pursuing a grand, noble mission despite all daily difficulties and obstacles. It may show you that you are not alone in your struggles, and thereby restore any hope, idealism and sense of purpose you may have lost along the way and soften the feeling that you are wandering in the wilderness. It may give you the courage to improve what you see is faulty and correct what you see is wrong. Finally, it may show you that you are, in fact, a miracle worker.

SUB WAYS

Stanley David Gedzelman

# SUB WAYS

Memoir and Reflections of a Professor  
Turned High School Substitute Teacher



On the path to the roots  
of learning and teaching  
Stanley David Gedzelman

***Sub Ways:  
Memoir and Reflections of a Professor  
Turned  
High School Substitute Teacher***

**Stanley David Gedzelman  
Professor Emeritus of Atmospheric Sciences  
City College of New York**

**To my Brother, Robert,  
All dedicated Teachers,  
and  
All aspiring, struggling, and sometimes  
suffering Students.**

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## Preface

**Welcome!** Imagine touring a TV station. The studio is filled to capacity with enthusiasts who ordered tickets days ahead or waited hours on line to see their favorite show. The black ceiling is crammed with lights and advanced technical equipment. Robotic cameras capture the show from multiple angles. Assistants inform the audience how to react, and guards are ready to remove anyone who gets rowdy.

The actors walk on stage and the show begins. They are dressed to the nines, expertly coiffed and made up. If they forget their lines, they can read as they glance into the camera or be prompted by hidden cue cards.

To the side of the studio, in the darkened production control room laden with the latest audiovisual equipment, a tech staff led by a producer and director guides the actors and packages the show perfectly.

Leaving the studio, you pass rooms where writers create the scripts, programmers code the animations, designers fashion the costumes, and a host of artisans and engineers design and build the sets.

Now, imagine you wander into a room where there is one trouper who wrote the scripts for five shows daily, bought the clothes, dressed and coiffed alone, created the sets, and produced the graphics. Imagine that that there is no audiovisual room, that all equipment on the ceiling is gone, except perhaps for a single projector and one computer bought and run by that trouper. Imagine that the audience consists of adolescents compelled against their wills to be there day after day, that 10% are mentally slow, emotionally troubled, and disruptive. Imagine that complaints pour in about how poorly the most disturbing members of the audience are treated and that the trouper is ordered to change the scripts and performances to accommodate them at everyone else's expense.

**Wake up!** You are no longer in the TV station. You are in a school. And you are not watching an applauded actor perform to an audience; you are watching a teacher at work with a class of students.

Now, come to class on a day that the normally somewhat restrained students have been told they will not be having the regular teacher, that whatever they do on that day will not impact their grades, and that *you* are taking the regular teacher's place. You have just entered the Twilight Zone world of the SUB!

**But wait!** Amidst the chaos, you notice one student's eyes open wide with a new sense of wonder because of something you said or did. You may have changed, redeemed, even saved a life, and perhaps the world. You have taken part in a miracle.

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*Throughout the book, Blue text indicates what I said, usually in class;  
Red text indicates alerts or extra material.*

# *Sub Ways*

## Stanley David Gedzelman

### Prelude

What educated, financially secure, retired person in his or her right mind would ever take the job of substitute teacher? Consider the timeless wisdom in the following two *misquotes*!

It is a truth universally acknowledged that a Substitute teacher in possession of a good class is the recipient of a remarkable fortune. However little known the talents and knowledge of such a Sub may be on his first entering a classroom, this truth is so well fixed in the minds of the students, that the Sub is considered as their rightful property.

Jane Austen, *Pride and Prejudice*.

Indeed, I entered the world of substitute teaching with *Pride and Prejudice*! Not all Subs do. Instead,

Most Subs lead lives of quiet desperation.

Henry David Thoreau, *Walden*.

This desperation extends over a range of issues, in particular, regarding the Subs' limits to their,

1. Authority
2. Knowledge of the subject
3. Knowledge of the students

Students, by contrast, are armed and ready for a day of freedom and abuse. "Let the games begin!"

In this Memoir you will enter my classroom and my mind. I describe my experience as a Sub and reflect on the world of Education. The Memoir's core is anecdotal but I strongly suspect it has value. Anecdote, which dominates the news in the form of tear jerker stories or vignettes designed to make you feel victimized and angry, is now out of favor in the halls of academe while statistics reigns supreme. But provided that neither statistics nor anecdotes are cherry picked with an ax to grind, *anecdote is statistics with sample size = 1*. Remember also the quote,

erroneously attributed to Mark Twain that “there are three types of lies – lies, damned lies, and statistics.”

And while scholars relish disparaging anecdote, consider again *Walden*, now universally regarded by scholars as a classic of wisdom even though Thoreau boasted, “I should not talk so much about myself if there were anybody else whom I knew as well.” Let us take Thoreau at his word without dwelling on psychological and neurological experiments, backed by rigorously conducted statistical tests, that we are all active victims of self-deception.

I conjecture with some knowledge and some extrapolation on what is taught, how it appears to be taught, what is learned, who is learning, who is teaching, how they are teaching, and on the decisions in the Kafkaesque back offices of the Education Empire. I reflect or pontificate on some of education's eternal issues with admitted stridency but hopefully, objectivity.

From what I have seen and can infer, most teachers are good, dedicated, hard working, underpaid, underappreciated, and, too often, unduly harassed professionals. Many are excellent and some are outstanding, certainly in the San Mateo High Schools. But as for the octopus of the Education Empire, that amorphous, engulfing amoeba of ‘administrators’, politicians, educational professionals, union officials, text book publishers, educational supply companies, and assorted activist citizens with all their conflicting ideologies, agendas, fears, and egos – well, that is another matter, and I will address it.

This is not the memoir of a hapless neophyte spending his or her first year with students. I came to subbing after a lifelong interest in teaching and a 42 year career as a Professor of Earth and Atmospheric Sciences. Since my background and persona influenced what I brought to class as a Sub it is important that I first give you some highlights.

I started thinking about good and bad teachers in First Grade. Mrs. M disliked me because I couldn’t figure out her name when she referred to herself in the 3<sup>rd</sup> person, saying, “Mrs. M wants you to...” and thought she was referring to the real teacher who would soon appear.

I may also have had a precocious interest in psychology, which is a critical component of teaching. When I was in second grade, Steven M was a behavior problem. I secretly told Mrs. H that if she gave him a post such as blackboard monitor he would act better. She did and he did. But a few weeks later, when I took my turn as class rascal, Mrs. H loudly announced, “Stanley, you can control Steven but you can’t control yourself.” I saw that Mrs. H had made a big mistake. By confessing that Steven’s honorary post had all been a ruse it could have embarrassed him and furthermore, returned him to his errant ways.

Despite ongoing thoughts about teaching quality, the first time I ever gave more than subliminal thought to a career in teaching was in my junior year of High School when I struggled in trigonometry and felt that it would be a valuable thing to make learning easier for others.

I made a few early forays into teaching. During summers in College I worked as a lifeguard. The lifeguards made up to \$60 per week, but the instructors who gave private swim lessons earned \$100 per week, a fortune at that time. So I took a Swim Instructor's course, in which I learned nothing about teaching, but got my Red Cross License to teach lifesaving and give private swim lessons. So, in my 4<sup>th</sup> year as a lifeguard I became an instructor.

On the first day I had almost no idea of how to teach swimming. My first student was a 6 year old boy. I asked him, "Can you swim?" He said, "No!" I then asked, "Are you afraid of the water?" He said, "No!" So I said, "Show me what you know!" and he swam! In some screwy way, that lucky success quickly helped me learn to teach. Within a few weeks, I had almost instinctively developed a key I would later use for teaching anything – a step-by-step approach:

1. Conquer Fear of the Water (Wash your face or blow bubbles)
2. Learn to kick off and glide (dive on a bed with outstretched arms)
3. Add kicking (with a kickboard)
4. Add a few arm strokes without breathing
5. Add breathing

Using this approach, almost all kids at least 4 years old learned to swim freestyle after a few half hour lessons, and some, in the first lesson. Kids much younger than 4 years old didn't seem to have the musculature to swim.

I had long thought about how our minds work. As I taught the kids to swim, I watched them think. For kids less than 6 or 7 I taught in a story book manner; older kids had a strong enough sense of reasoning so that I could explain things such as, "When you push the water back you go forward." I taught one adult and saw the combined physical and mental stiffness that no kid has. From that summer as swim instructor, without the benefit of a single education course, I generalized to formulate ideas of teaching and learning that I believe are valid and valuable.

It was as a lifeguard that I developed my lifelong antipathy to Administrators. The moment two of my friends got promoted to lieutenant lifeguards, they became intolerably imperious and officious. Their metamorphoses made me realize how difficult it is to exercise power fairly. I vowed never to be a boss (other than a professor), never to

abuse power, and always to keep myself as independent as possible. I believe that I largely succeeded.

In my first semester as a graduate student I volunteered to teach poor kids from Roxbury, MA in a Saturday Science Program. I was assigned to be assistant instructor in Physics to Harry Koons, an advanced grad student, and had little to do. Harry did OK with the kids. At last, he told me to choose a topic to teach the next Saturday. I chose to show how the Moon orbits the Earth. I constructed a demonstration using a straightened metal hanger, a large and small plastic foam ball, impaled on opposite ends of the hanger, and a string to suspend and balance it all so that it would spin to mimic the orbits. It worked but the kids' had absolutely no idea of what I was demonstrating or talking about. Their knowledge and conceptual development were so poor and backward I was stunned. I saw my efforts as fruitless and promptly quit.

In my third year of graduate school I took a course in Advanced Atmospheric Dynamics from Jule Charney, the scientist who with John von Neumann led the project that developed the first computer weather forecast. Charney, an extraordinary scientist, both spoke at conferences and wrote with great clarity and insight but was a poor in-class lecturer. He would spend huge chunks of time standing silently in front of the blackboard trying to advance the derivation of some new theory. There were moments when he backed away from the board and would give us golden insights, but they were few and far between. Making coherent notes of his lectures was a challenge. I had already established the practice of taking rough notes in class and then polishing them at home by integrating physical insight with the mathematics.

One day I came to Charney's office with some questions and in the process, showed him my notes. When he saw them he asked, "Did I say this? Can I Xerox them?" It was actually very funny. But that, plus the fact that I knew that as a world expert there was not a drop of spite or pettiness in him, gave me the courage and the gall to comment on his teaching. His response was, "Gedzelman, this is a graduate course, not an undergraduate course. You have to know that there are problems in the field." I was equal to his challenge. I answered, "Yes, but when you are standing silently in front of the board with a problem, let us know what you are thinking and what is giving you such trouble." His eyes opened wide and he said, "That's an excellent idea." But he never did change at all.

In the spring before my last (fifth) year of graduate school, my thesis advisor, Victor Starr, asked me to teach his course on the General Circulation of the Atmosphere. What an honor and responsibility! Over the summer I spent days assembling course notes, as there was no text in

the subject. However, just before the fall semester began, the faculty vetoed having a grad student teach a graduate course, so my notes lay idle and the start of my teaching career was postponed. It was probably all for the good; it made it easier to finish my PhD thesis.

During my last year in grad school I suddenly awoke to the fact that I needed to get a job. I interviewed with the Rand Corporation and realized I wanted much more academic freedom and diversity of subject matter than any engineering firm could offer. By chance, as Thanksgiving approached Professor Norman Phillips (who wrote the first climate model) told me of an opening for an Assistant Professor at my old Alma Mater, the City College of New York (CCNY). Since I was going home to NYC for the holiday, I arranged an interview. I felt it was just for practice because I wanted to go to California. As a result, I was light hearted and totally relaxed during the interview. I recognized some old professors, though one, Ely Mencher, I couldn't place. Then Ely reminded me that he had been a professor at MIT in the Geology Department and that we had met numerous times, but only in the elevator, where I had always been very friendly.

Among the questions my interviewers and future colleagues asked me, two stood out. Could I teach hydrology? I told them that I had taken a hydrology course in graduate school, enjoyed it, and added, "[I can learn just about anything and anything I learn I can teach.](#)" The second question grew out of the campus unrest and riots as the Vietnam War began to wear down in 1969. What would I do if a student radical came in while I were lecturing and said, "Class is over, the Revolution has begun." Now there wasn't much anyone could do if the radicals were in sufficient numbers and had enough student sympathy, so I thought it was a ridiculous question and I gave an equally ridiculous answer immediately with a straight face, "[I have a brown belt in judo and would kill anyone who tries that.](#)" My future colleagues were so shocked by my answer I could see their bodily reactions; they may have hired me more for protection than for my academic potential. As it turned out that was my only academic interview and only job offer; the Vietnam War Recession intervened and openings diminished to a trickle.

The first day of my teaching career at CCNY in September, 1970 was chaotic. I had just returned from France, where my brother, Jack got married, and had finished my thesis defense just before leaving for France. I was scheduled to teach the introductory course in Meteorology and had only prepared notes for the first lecture, the origin of the atmosphere. I walked into the lecture hall a nervous wreck. As I was about to start, my older colleague, Al Ehrlich, walked in and said, "Don't worry, Stan, I'm teaching this course." It took a minute or so for what he

had said to register. So, my teaching schedule that semester was easy – 2 labs and Climatology, the latter which I decided to upgrade from the descriptive course it had been. Three of the 11 students promptly dropped, saying that even though they had taken Calculus they had forgotten it all and were only looking for an easy A.

That first year I moved three times, furnished my apartment, started a research program, and courted and married my wife, Bernice. So, I remember little about my teaching that year. The labs covered plotting, contouring, and analyzing weather charts. None of the physics and math I mastered after great struggle had any relevance to the baby stuff I had to teach in the labs.

I focused my efforts in Climatology, a much neglected, even spurned field in those ancient days. I began to construct a course and notes that consisted of three sections – principles, climates of the world today, and climates of the past. Paleoclimatology incorporates findings from geology, astronomy, biology, as well as oceanography and meteorology. I learned quite a bit and loved it.

At most universities, the prevailing attitude toward the acquisition of teaching skill by new professors was, sink or swim. Outstanding teaching was a little regarded bonus. Tenure and promotion depended almost exclusively on research and, as the years rolled by, increasingly on research grants. Even great teachers had no chance at tenure and less than zero chance at promotion if they didn't have commendable research. In fact a miniscule teaching load was and still is one of the primary marks of distinction at the universities.

Connected to this attitude was a hierarchy of snobbism regarding academic disciplines. Physics was vaunted at the top, compliments of Einstein, the Atom Bomb, and Sputnik, while Education was ridiculed at the bottom. (Other baby majors were just being invented at CCNY along with Open Admissions.) Much of the faculty in the School of Education had the ironic but widely acknowledged reputation for poor teaching, and the Ed majors were seen as the dumbest of all the students. I largely concurred in this assessment, but dissented on the issue of the cavalier attitude toward teaching excellence, which I considered to be both critically important and an innate talent almost impossible to teach to anyone who did not have it.

So, regarding my teaching, I was largely left alone to find and learn my own way. But there was one notable exception. By contract, my teaching had to be observed once a year.

For my first observation I lectured on the geologic and fossil evidence of past climates. By doing so I unknowingly trespassed on a specialty of the observer, Ely Mencher. I delivered what I thought to be an excellent

lecture with only one glitch. Midway through, I forgot the climate consequence of evidence of swamp and bog deposits and had to slowly and carefully reason my way out. I came home upset at my glitch. A few days later, Ely called me into his office for his review and evaluation of the lecture. Wow! He used his in-depth knowledge to instruct, correct, and refine innumerable points. It was a wonderful, memorable learning experience. Everything I had thought to be great about my lecture had failed to impress him. What did impress him was the way I had reasoned my way through my self-created morass.

Incisive reviews are always helpful, and I had too few from my colleagues. For, if I had no idea of what Ely was thinking I also probably had little or no idea of what my students were thinking. Another senior colleague, Charlie Baskerville, told me midway (the eighth week) through his first semester of teaching hydrology a student asked him what the unit hydrograph was, a fundamental tool and concept in that field he had been lecturing on from day #1. When all the other students agreed, Charlie realized that he had to start all over.

Despite my shaky start as a teacher, I soon found my footing, and in an odd way, it helped that I always ‘volunteered’ to teach the courses my senior colleagues didn’t want to. Thus I developed a course portfolio that included Statistics, Climate, Cloud Physics, Radiation, and Weather Station Operation. This diversity greatly amplified the development of my teaching skill in each course. I also reluctantly taught one Grad Ed course in meteorology (but at freshman level, of course) to a group of Bio teachers who took it because no Grad Ed Bio course was given that semester. All I remember was one funny incident. The disgruntled teachers complained about the difficulty, etc. Finally, the class rep told me, “You know, we didn’t want to take this course.” To that I responded, “[You know, I didn’t want to teach it.](#)” After that there were no more complaints – at least to me. Apparently we had a perfect mutual understanding.

As my 4<sup>th</sup> year approached, I lobbied for and was finally assigned to teach *Introduction to the Atmosphere* for non-science students, largely because enrollment had dropped below 35, which represented a major loss to the Department. Over the summer, I went to the head of the Office of Curricular Guidance and promoted the course. No surprise – that fall, 97 students appeared in the class. None of my colleagues checked the real cause for the tremendous enrollment increase, so I won the unmerited reputation as an excellent, inspiring teacher. Somehow, I neglected to disabuse anyone of this notion.

Why did I want to teach a required course that I knew so many liberal arts students would hate? Even before reading C. P. Snow’s influential

book, *The Two Cultures*, I felt that the snooty divide between artists and scientists was counterproductive to progress in modern society and hoped in some measure to narrow that divide. Besides, I always fancied myself a Renaissance man, loving both the sciences and the liberal arts. I was aware that the split between science oriented and arts oriented people widens to a chasm around the time of puberty and adolescence. So many people decide at this age that they hate math and science. One of the reasons is that this is also the time that the teaching of science metamorphoses from a friendly Mr. Wizard approach to a far more formal, impersonal, rigorous, abstract and, unfortunately too often, authoritative approach.

Being aware of this great gulf, I humanized my science teaching as much as possible. Initially drawn to meteorology by the power of the atmosphere, I became increasingly aware of and sensitive to its beauty, and stressed both the awesome and aesthetic aspects in my lectures. I also stressed the impact that weather and climate have had on history, art, music, literature, and on our daily lives and even on our psychology.

It took me much longer to realize or, more accurately, to acknowledge that even among college students, and especially at CCNY where so many were coming from poverty, that there is also a great gulf between those of academic bent (egg heads) and the far greater number who simply want a degree as a ticket to a better paying job and life. Thus, many liberal arts students don't like the liberal arts! Hopefully I at least entertained some of them.

Knowledge was growing so rapidly in the Earth and Atmospheric Sciences that the content of courses changed from year to year. There were few texts in standard courses and none in some courses and, in any event, they were seldom adequate. So not only did we design the lectures and labs in the courses we taught, I also wrote detailed course notes in the tradition of my professors in graduate school, and turned one into a text, *The Science and Wonders of the Atmosphere*.

In every case, the first time I taught a course I constructed a good framework with the proper elements, but it was only the second time that I was able to develop a holistic overview. After that, I made only minor improvements and changes to the structure of the courses aside from incorporating new knowledge and technology.

My teaching range broadened in 1995, when our department's mission was redefined. I learned and taught hydrology, geology, and a practical computer course for undergraduate science majors involving the formulation, analysis, solution, and presentation of scientific ideas and problems. A final addition to my repertoire occurred in my last two years

when I co-taught freshman writing whose topic was one of my research specialties, the history of how artists have depicted the sky.

I adapted my teaching style to suit the level and nature of each course. In the basic large lecture courses, showmanship is a considerable part of teaching, and I was pretty good at it. In the advanced theoretical courses, where mathematics and increasingly, computer skills were central, lectures were more formal, and I made sure that competent students understood the theory and concepts well enough to be able to formulate and solve at least standard problems.

In the practical course, I acted as master to my student apprentices. In that course, after the first test the students constructed and delivered most of the lectures, based on lab exercises I had designed. Finally, for undergraduate or master's research projects and theses, I served as mentor and/or collaborator. There you really get to see the students' thinking.

One of the most delightful features of subbing is that Subs don't give grades or tests. Testing (with grading) is the only part of teaching I didn't love, and which I hated. But testing is an essential part of teaching and learning. I always chose tests that required active display of knowledge or skills, for they keep students honest, require them to work more, think better, and are learning experiences. I am proud that in 40 years of teaching I succumbed only once and gave only one multiple choice test. I consider multiple choice, matching, and true-false tests to be immoral copouts by the teacher. Most likely, good students will perform well and bad students will perform poorly on any type of test, but multiple choice tests allow students to do and learn as little as possible.

In all courses I fixed on and announced standards the first day of class, and held them throughout my career except once (see Day #4). For example, in introductory courses test averages at least 82 = A, 72 = B, 60 = C, 50 = D. I taught what I thought essential in each subject, so I tested to my teaching and did not teach to the test! Each test contained 10 short essays or problems – no multiple choice, true-false or fill-ins. At CCNY I posted some 20 questions *with answers* on a bulletin board a week before each test, and 8 or 9 of these I gave on the test. I fixed a point system for each question, For example, one question I asked and promised my students that I would ask every semester in Meteorology and Climatology was, "Describe and Explain the Atmospheric Greenhouse Effect". I allowed students (many of whom were poor in English) to use labeled diagrams (e. g., of a Greenhouse) in place of verbal descriptions.

**Description of the Atmospheric Greenhouse Effect**

1. *Solar* radiation easily penetrates the atmosphere and is absorbed at the ground. (1 pt.)
2. The heated ground emits *terrestrial* radiation upward. (2 pt.)
3. Terrestrial radiation is largely absorbed by the atmosphere so that very little escapes *directly* to space. (1 pt.)
4. The atmosphere reemits terrestrial radiation both up to space and back down to the ground. (1 pt.)
5. The extra radiation received at the ground produces Greenhouse warming. (1 pt.)

**Explanation of the Atmospheric Greenhouse Effect**

1. Solar radiation consists of short waves (largely visible light and short Infrared Rays) which no atmospheric gas absorbs well. (2 pts.)
2. Terrestrial radiation consists of long Infrared rays, which the minor atmospheric gases whose molecules have three or more atoms (CO<sub>2</sub>, H<sub>2</sub>O CH<sub>4</sub> and O<sub>3</sub>) readily absorb and emit. (2 pts.)

Despite such explicit standards, there were always students who protested the grading of their answers. I eventually learned to perplex them by asking absurdly if they had come to demand that I *lower* their grade because I had given too *much* credit. To watch their faces when I asked this made other nearby students chuckle. Eventually, I promulgated a standard policy; all protesting students had to submit both *their* answer and the *correct* answer in writing and justify how many points they should get, given my system. In all the time I used that policy (more than a decade) not one student ever did.

One semester early in my teaching career I gave each student an oral test in my office, but realized that it would subject me to accusations of favoritism or worse. Also, after I tested a few students the rest knew the questions. Too late it occurred to me that the student ‘communications’ actually have a substantial educational value. (Call it desperation learning.) I should have played more such games. Of course, individual oral tests are not possible in large lecture classes.

Late in my teaching career I used a trick. As the students piled into the room to take their first test I put on a mournful face and gave some nonsense excuse for not having it ready until the next class meeting. A few students got upset, but the vast majority breathed a collective sigh of relief. I then answered any remaining conceptual questions and pointed out any factual errors. This improved the average results of the first test.

In my junior year of college I discovered that if I listened and concentrated intently in class, I did not need to do anywhere near the

amount of homework and studying I had to do if I were daydreaming in class or gawking at the beautiful girls. I took that lesson to heart in my teaching as well, so whenever it was possible I tested how well my students were listening.

Around the year, 2000, I learned about Metacognition (self awareness). I had the students estimate their grade on each test, and from their consistent biases, began to better grasp their levels and limitations of self-awareness. Despite pointing out the students' biases, they continued unabated and I never succeeded in getting this to help them improve their grades. As a result, I strongly suspect that claims about improving students' metacognitive skills or abilities are exaggerated.

I had students in the introductory lecture course grade their classmates' daily quizzes and found that when students performed poorly on a quiz they were unable to grade it accurately despite being given the answer key and explicit instructions regarding the point system.

While I am on the subject of metacognition, it is appropriate to state my self-assessed, personality traits that impact on teaching, even as I acknowledge that self-assessments are suspect. For surely, whatever teaching skill I possess grew out of and fit with my personality characteristics and self-assessments. I came to class confident, love being a showman, and am admittedly too egotistical (hence this Memoir). But I feel it is vital to help people learn, and love seeing the light go on when people finally understand or master something. And, I deeply admire accomplishments, skills, talents, creativity, and excellence in others.

I have an excellent sense of humor (for a professor), am sarcastic and somewhat cynical but idealistic, judgmental but fair and kindly, and unsympathetic but understanding to those who do not work and perform, though I have always sympathized with anyone trying to learn and with all students stuck in hated required courses. I am an independent rather than a leader or follower, although, of course I was the leader in each class I taught. Being a cynic, I am nowhere near as inspirational as I would wish and am a terrible salesman.

Metacognition aside, any teacher who is conscious, who watches and cares about how students are suffering, struggling, living, learning and enjoying will arrive at certain insights and understanding. And the student body at City College was global and so diverse (over 110 languages were spoken), that everyone was exposed to multiple cultures with all their similarities, differences, and yes, their pitfalls and glories.

In teaching over 40 years, certain serious and certain funny constants emerged. First, my best students exhibited three characteristics. 1: They catch and hold the subject's logical framework. 2: They find the critical facts necessary to hold up the framework without getting bogged down

in irrelevant details. 3: They think that their approach does not indicate talent (it does) but is simply logical and necessary (it is).

Second, most students from all cultures and in every generation rely far more on memory than on logic and reasoning despite the fact that reasoning is the glue that holds facts together, and that undue reliance on memory serves particularly poorly in the physical sciences. Probably, we have been designed to rely on and trust memory because it has been so important early on in preserving human progress and also because it implants the ingredients needed to construct logical frameworks and habits, thereby making us more highly functional. Nevertheless, poor but hardworking students stubbornly cling to their faith that brute memory alone will enable them to conquer a subject, and do not get its essential logic. Inevitably they get overwhelmed and drown.

In *Reading Lolita in Tehran: A Memoir in Books*, Azar Nafisi presents an extreme example of students' undue reliance on memory on one of their tests.

Most of the class, rather than respond to the questions, had simply repeated my classroom lectures...in four cases, word for word...including my "you know's"...a bizarre parody of my own lectures.

I thought they had cheated. It was inconceivable to me that they could have recreated my lectures so precisely without notes. My colleagues, however, informed me that this was regular practice; the students memorized everything their teachers said and gave it back to them without changing a word.

In its attempt to stanch students' undue reliance on memory, the Education Empire imposed one of its many magic elixirs, *Inquiry-Based Learning*, a renamed Socratic Method grafted from the Social Sciences, where it works, to Science, where it doesn't. The teacher (who is not allowed to teach) gently prods students to ask questions that will lead them to rediscover Relativity and Quantum Mechanics. In essence, Inquiry-Based Learning aims at recreating the Scientific Revolution by following the Ancient Greek approach to Science of granting primacy to a priori reasoning or innate insights, which proved instead to be barricades to scientific discovery. Ever hear of labs and experiments?

Third, the overwhelming majority of students found processes and problems involving two or more steps of logic or math to be far, far more difficult than processes and problems involving a single step. This made it essential to number list all steps in any chain of reasoning, which the bulk of my students then committed to memory. Successful memorizing

did, however, appear to make it possible for them to understand and internalize the material better.

Fourth, so many non-science majors had such deep math phobias that they complained bitterly about questions involving an equation despite routinely averaging higher on such questions so long as the equation appeared on the test exactly as it had in class and in the homework.

Fifth, students found it much easier to comprehend topics that could be visualized and animated than abstract ideas. Thus, the sea breeze was a breeze for most students because everyone could see smoky air rise from a burning candle and because you could draw arrows to indicate the winds, while concepts involving water vapor (which is an invisible gas) always gave trouble. Computers have amplified this characteristic.

Sixth, almost no one ever studied or read ahead because we are all propelled by deadlines and, given our frantic, multitasked lives, are compelled to triage. I would address my classes with great irony, saying, “Since the best way to do well in any course (and in any job) is to read the material and try to do any problems the day before the subject is given in class, never, I repeat, never look ahead because you might succeed.” I don’t know if my warning was taken to heart and improved things. Properly used irony and sarcasm can motivate people.

I saw striking academic differences (on average) between the sexes even though overall performance was quite similar. Men constituted the vast majority of weather nuts. Men also preferred the physical sciences while women tended to prefer biology or geology. The first two times I taught the large introductory lecture in the early 1970’s no woman earned an A, but from the late 1970’s more women than men earned A’s. I attributed this largely to the relaxation of societal restrictions and taboos once imposed on women and not on any innate lack of ability because I met too many brilliant women mathematicians and scientists as a graduate student at MIT to ever assume women couldn’t do math or science. But it did appear to me that women students work harder while men seem to rely more on fast, but often less organized insights, and as a young student I surely exemplified the latter category.

One demonstration illustrated in a humorous way a significant non-academic difference between men and women. Every semester I used the classic Magdeburg Hemisphere experiment to illustrate atmospheric pressure. I held together two rigid, hollow metal hemispheres 4 inches in diameter (with an O-ring to prevent leakage) and pumped the air out. If you let the air back in, the hemispheres fall apart, but with the air removed it takes great force (over 100 pounds) to pry them apart. I always chose two petite women ‘volunteers’ to come up to the lecture hall stage and try. Each held the handle of one hemisphere. They then

proceeded to alternately pull each other with such uncoordinated, jerky motions that everyone laughed and in 40 years no team ever succeeded in pulling the hemispheres apart.

Then I got two large men to try. They often made the same jerky start, but quickly made silent eye contact with each other, took a stance with legs spread apart in a line and then quietly coordinated their pulls so that they plucked the hemispheres apart, followed by my comment, “[You lost your diaphragm](#)”, as the O-ring popped out onto the stage floor.

Biases in the ‘experiment’ are obvious. I chose petite women so that even if they had coordinated their pulls they would have had a tough time, but the point is that they never did coordinate. I also always had the women go first. You may have agendas on issues of women’s rights and differences between and/or similarities of the sexes, but here was a demo of a striking difference, that rose above all biases in experimental design.

Despite any academic differences that I perceived or any general conclusions I arrived at regarding the sexes or any groups, I was more than occasionally surprised, sometimes quite so, and enjoyed being pleasantly surprised. People’s variations help make us and teaching so interesting. All this reinforced my practice and philosophy that whatever might be my prejudices, I aimed at and succeeded in judging and certainly grading every student solely on their performance.

### **Teacher Parent**

I must mention one final, important aspect of my teaching career—the education of my children and grandchildren. All parents are teachers, but for my kids I was a teacher among teachers. I watched and fostered their development at every stage, always keeping in mind what I had learned in life, sometimes the hard way.

Early on, there were words, led by nouns. I intrigued them, pointing to shoes and flowers and lovingly repeating the words. Then there were stories, starting with simple ones like Aesop’s Fables. Gradually, the stories got more involved and complex. Children love to hear the same stories over and over until and after they have internalized them and their messages. Because I knew the power and importance of listening well I used the stories to develop my children’s listening skills. At each telling they had to fill in words to show they were listening and understanding. The Aesop’s Fable, *The Fox and the Crow*, is a good example.

Once upon a time there was a \_\_\_\_ [crow]. He found a piece of \_\_\_\_ [cheese]. Then he flew into the top of a \_\_\_\_ [tree]. He was about to eat the \_\_\_\_ [cheese] when along came a \_\_\_\_ [fox].

By doing this I was sure when my children understood the story, the implications, and the moral. They also appeared to enjoy participating.

Realizing the technique might help my college students become better listeners I told them what I had done with my children and then used the same approach occasionally on them. Did it help? I don't have any measure, but it is likely that at least some students took it to heart. One thing that I know for sure is that my now grown children are excellent, incisive listeners (and excellent teachers too).

I taught each child to swim at 3½. Evan was compliant. Elise, the rebellious, had no choice because she violated our explicit, repeated order not to climb the fence into the pool grounds and then walked out onto the diving board, when I was stupid and careless enough to take my eyes off her in the huge apartment playground for a few minutes. I taught each child to ride bikes at 5 by holding the back of the bike seat as I ran behind them and letting go for longer and longer stretches, knowing that the faster bikes move the greater their stability.

When my children were about 2 years old (if my memory is correct), I began to teach letters and numbers. I tried to teach reasoning and cause and effect. It took time but it worked.

When Evan was 6 I watched him play a game at a festival. On a tilted plywood board the kids had to get a matchbox car pass through a gauntlet of two rows of pins and go over the edge. Evan carefully watched several kids try to ram the cars down the gauntlet, and their cars always veered into the pins and were stopped. Evan aimed the car carefully, let it roll gently and won.

One time, when Elise was 5 (and Evan was 8), I gave Evan a \$20 bill and gave Elise 20 \$1 bills. For a moment Elise was ecstatic. Then she began to think, slowly counted out the bills, and realized to her great disappointment that, "I didn't get any more than Evan." I was overjoyed. It had been a test as well as a gift, and she passed with flying colors.

I taught frugality and discipline as I lived it myself. They learned the value of a penny because I promised them that I would give them 10 times whatever money they would find (but not steal). They immediately asked a series of pertinent questions. "What if we find \$1? Would you give us \$10?" "Yes!" "What if we find \$100? Would you give us \$1000?" "Yes!" "What if we find a million?" "Well, kids, there *are* limits." That almost satisfied them.

So, my kids turned into fanatics. They looked for money everywhere we went. Elise was particularly dedicated. If we went into a 7-11 she would dive under the various soda and frosty machines. Sometimes, she found as much as 50 cents. Washing her clothes surely cost more.

My kids told their friends, who couldn't quite believe it at first but became insanely jealous when they saw it was true. When my niece, Severine came over one summer from France and was told that the offer included her, she salivated at the prospect of immense wealth. She was ecstatic to find a dime in a parking lot; no matter she almost got herself run over in the process.

Back to frugality! One evening, when Evan was 10 and Elise was 7, we passed an upscale candy store on Manhattan's Upper East Side. Of course they wanted everything. I held two \$10 bills in front of them and said, pointing to the prices, "Here, in this expensive, rip-off store, block chocolate costs \$12 per pound. In *Economy Candy* near Grandpa and Grandma, in lower Manhattan the exact same chocolate is \$4 per pound and we'll go there the next time we visit." Then I gave each kid their \$10 bill. They thought for only a moment, pocketed the bills in unison, and didn't waste a nickel in the upscale, rip-off store.

School choice has long been an abiding, major issue for parents. *The Good School* by Reg Tyre is a parents' guide for picking good schools. It made me recall how we chose our kids' schools. I had immense confidence that I could assess teachers and schools. After all, I had spent my life in education and had always been concerned with making learning easier. Not everyone has that advantage, so not every kid would have the advantages we gave our kids in school.

We had absolutely no inner turmoil about the kids' preschool and kindergarten. They went to the Fort Lee JCC. The teachers were good and dedicated and the kids thrived. Was it perfect? Of course not! One time when Evan misbehaved, one of the teachers forced him to put a diaper on to humiliate him. The teacher was chastised, the incident not repeated, we all talked about it, and it faded into the background. Today, the teacher probably would have been fired.

Primary school had 4 possibilities – the local public school, two Jewish Day Schools – one conservative and one orthodox – and an upscale private school. We visited the conservative Solomon Schechter School first. Its program has half a day of secular studies and half a day of Hebrew, with an admixture of religion. The Hebrew teachers were Israeli. That provided a near guarantee the religious aspects would be 'contained'. The building was tired and old but when we walked into the First Grade Class I saw immediately that the Israeli Hebrew Teacher was outstanding and that our kids would learn Hebrew. The secular studies teacher was OK. The kids were bright. Then we walked into a 3<sup>rd</sup> or 4<sup>th</sup> grade class being covered by the Secular Studies Coordinator. She was teaching a lesson in cultural relativity – all faiths are good, all ideas are good, all cultures are good. Ugh! It was too PC and too out of place with

a religious education. You must live ethics or morality; you can't teach it in a class (though you can diagnose bigotry and a bigoted state of mind).

Several weeks later we went to our town's Public School. We lived in an Upper Middle Class Condo embedded in a mostly working class town. The upscale parents either moved to upscale towns the moment their kids reached school age or sent them to private school. The public school class was crowded. The teacher was energetic and excellent but overwhelmed. And the public school kids were way, way behind the kids in Solomon Schechter despite the fact that we came weeks later. So the public school was out.

Some weeks later we went to the Orthodox religious school. When I asked the Principal, a rabbi, to sit in a class he asked me, "What do you need to do that for?" That very question showed me that he was right – the orthodox school was out.

After seeing these three schools and hearing about the stressed out kids at the Private School, I ruled that out as too expensive without commensurate superiority and did not visit.

So, the kids went to Solomon Schechter, where they got an excellent education and learned a good amount of Hebrew. Learning another language is marvelous and very important.

I was a great academic help to both children during their grade school days. I helped with their homework assignments and projects in school. I always worked with them, making sure that they understood and mastered the material. Early on, I typed their compositions as they dictated. Elise at first needed a little more help with writing, but soon both were flying on their own. I also sometimes played dumb to get the kids to explain things to me or deliberately made ridiculous errors to get them to correct me. I used these techniques as both a Professor and Sub.

I considered mastery of a musical instrument imperative. Since we owned a piano, which I play modestly well, that was their instrument. They took lessons and I worked with them so that it wasn't a case of me running off after yelling, "Practice, kid!" Evan loved music and became a fine pianist; Elise, the rebel, fought me but got good despite herself.

It wasn't all roses, of course. Each child rebelled from time to time. When I drove them to or from school, I always had them do the times tables and timed them. One day, when Elise was in First Grade she refused. I pulled over and stopped the car and calmly told her that I wouldn't move until she complied and that if she were late the teacher would be angry with her. She never objected again and ultimately won the award as best math student in her high school, went on to dual major in Math and French, and finally became an actuary.

At some point, when Evan was 9 or 10 he suddenly stopped doing homework altogether. No argument, threat, or punishment I could present had the least effect. Exasperated after a few weeks, I said to him, “Evan, I thought of giving you your freedom when you reached Bar Mitzvah at 13. But since you won’t listen at all to me now, you are free to do what you want, when you want and how you want.” Evan immediately became contrite and implored me, saying, “Daddy, tell me what to do.” I was floored. I had not even thought of using reverse psychology. His rebellion terminated that instant – and he was happy.

I had several shortcomings as an educator parent. I did not give them much fine literature or history, and what I did give I did not do very well. (I will return to these personal academic shortcomings, which I have worked to rectify.) I gave them little vocational training. Time was also a limiting factor. Evan had considerable artistic talent. In addition to taking piano lessons he swam six days a week, so there was simply no time for the Art Students’ League over in Manhattan, where my father served both as CPA and art student. Our daughter had ideas of becoming an actress, but her unscripted, unrehearsed plays bored me to tears and I was discouraging. Shame on me! I should have encouraged and guided her.

By the time Evan and Elise reached 8<sup>th</sup> grade, they could think and learn new material faster than I could, and had little patience to bring me up to date, so they seldom needed academic help. They were largely on their own and happy about it. And was I proud! This was one of my great triumphs and accomplishments in life.

Choosing a High School meant moving. Although continuing in the Solomon Schechter High School would make the kids become fluent in Hebrew I had had enough of religious rules plus an intolerably long commute. So it was getting indebted with either the Preppy Wasp Private High School or Public High School in an expensive house in an upscale town. So, we moved to almost rural Upper Saddle River, with a stream in our backyard and an excellent regional High School. Evan hated the school but Elise thrived in it. Much of Evan’s unhappiness was due to being a newcomer to a town where cliques were already established, but some was linked to my own professional and personal troubles at that time when my job was threatened and I lost my Dad. I think Evan was shaken by my temporary loss of confidence.

For college, we gave the kids a choice. We would pay 100% of what Rutgers, the State University charged plus 25% of anything more if they chose a more expensive school. I wanted them to be financially invested in any financial decision they made. They both settled on Rutgers and found all they could want there. Evan majored in Piano Performance, found a great mentor, and stood his ground when I challenged him about

choosing a major that had no visible source of income. Ultimately, after four very happy years, he announced to us on graduation day that he was not going to attend Music Conservatory but instead go to Med School (which took him two extra years of preparatory study and work). We almost fell over. Elise dual majored in French and Math and upon graduation moved to San Francisco and became an Actuary. We had lucked out with our kids but had helped to make our luck.

### The Sub Arrives

Thus, I came to subbing open to learning but with established ideas about learning, teaching, and administration, founded on firm principles and largely objective observations and knowledge of my brother's tales of joy and woe as a High School teacher, my wife's patient experiences as a Primary and Middle School teacher, and the experiences of many colleagues and teacher friends and relatives.

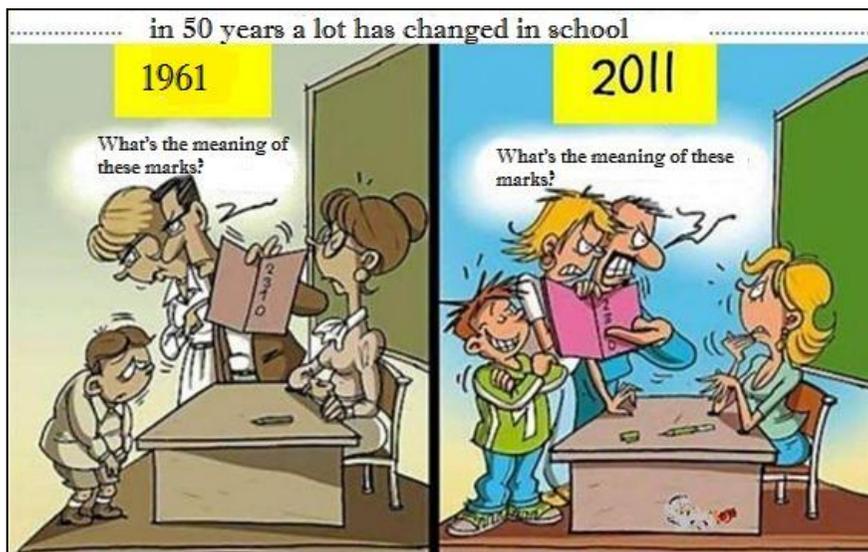


Fig. 1. In 50 years a lot has changed in school. WeKnowMemes.

The bulk of my assessments on High School Education in America have been strengthened by my exposure as a Sub to two major issues that permeate the classroom but originate outside it. First, the schools suffer from a simultaneous Orgy of Responsibility and Famine of Authority. Schools and teachers now are held responsible for any and all student problems as Figure 1 sardonically portrays. Linked to this is the second issue – the Education Empire – whose constantly oscillating dictates on

Pedagogy sway with the political, economic, and intellectual wind, but rivet and re-rivet the hapless teachers into ceaselessly fluctuating practices, all the while rendering them administrative beasts of burden.

Where should responsibility for learning lie? There are clear bounds. For the first years of life, the parents must assume enormous responsibility. They must not squelch but must encourage and provide discipline for the child's natural curiosity and desire to learn. Once the child enters school, the teacher assumes some responsibility and, in the early years, doubles as a daytime parent. With age the child must assume a growing fraction of the responsibility to learn that reaches 100% at adulthood. Teachers, parents, and mentors must remain as helpful as possible, but are no longer responsible. Any model that differs too much from this general framework is an aberration bound to fail.

Why did I choose to be a Sub, given my awareness of its drawbacks? It was certainly not my first choice. Upon retiring and moving clear across the country, I sought to keep active, to continue contributing to the sacred mission of teaching, and to remain around spirited, young people. I looked first for adjunct teaching positions in the local colleges. But this is the Peninsula, midway between San Francisco and Silicon Valley. It is a region laden with aspiring and (in 2012) underemployed talent. I couldn't get to first base. I was told to enter the "Pool", a computerized list of openings. There, my college teaching hopes were drowned, as have been the hopes of many, many others without personal connections.

So, no adjunct positions in the local colleges being available in the foreseeable future, I entered the bureaucratic labyrinth (redundant!) necessary to qualify as a Sub. I applied for High School subbing only, not wishing to deal with a class of Primary School children all crying and wetting their clothes at the same time, or Middle School and Junior High School adolescents with their raging hormones and awkwardly incessant challenges to all adult authority figures. Six months later, I emerged from the labyrinth less dramatically and tragically than Icarus had, by which time I had taken the standard test given to all prospective teachers in California, confirmed that I had a BS degree (the PhD was considered irrelevant and not accepted), and testified under oath that I was neither a criminal, a sex deviant, nor a traitor. My claim that I was not a pervert was accepted after costly investigation and I got my badge and permission to substitute.

By the way, Bureaucratic 'Wisdom' has legislated that teachers must have taken an armada of Education Courses. I have never taken a single Ed Course and am almost proud of it. Yes, I never took an Ed Course but I *taught* some. Let me rephrase this so that it gains perspective. I am not permitted to replace a teacher on leave longer than one month because I

did not take the Ed courses that I taught. At the time, the wisdom and advantage of registering as a student in the Ed courses for which I was the Professor somehow eluded me!

To repeat, I have never taken an Ed Course....But I did have to take a one-day workshop to qualify as a Sub. That is Day #0.

Before we start, however, I must mention a small regret. I didn't start writing notes until several weeks after Day #0, when I decided to write *Sub Ways*. So, I forgot some early details. But I took that lesson to heart. On most days as a Sub I took notes between and right after classes and soon after wrote an enlarged account of these days. Later, I came back to review and generalize, including what I learned from reading, but retained the main events and core message of each day.

## Day #0: Training: Pedagogy and the Education Empire

The San Mateo County High School System mandates attending a one-day training session as the final prerequisite to entering a classroom. In the spring of 2014, four more days of mandatory ‘training’ sessions were added, and I attended one of these mandated days, which was a waste of time, except for learning from the experiences of other Subs!

But the one-day training session was well worth it. It was well organized, well run by a team of enthusiastic Leaders, and accompanied by a detailed ***Guide and Instruction Manual*** with information about emergency procedures and contacts, and tips for survival. Lectures were given by several experienced teachers who had become Subs upon retiring. One was a genial fellow who really liked kids but didn't care if he didn't know the subject, which he found to be the case quite often, as he was neither a scientist nor a mathematician.

One of the things the Leaders did that struck me was to have us act in a skit. Skits, frequently with tendentious themes and morals are very popular, indeed, mandatory in Ed workshops. They are sometimes informative but almost always awkwardly artificial. But in this case the skit worked because it was a ruse. We were instead, unwitting participants in a psychology experiment designed to show us how handicapped or vulnerable students feel. When anyone stammered a response to a difficult question, others almost automatically piped in to ‘help’. That help didn't make anyone feel good. Thus, we were all uncomfortably pigeon-holed by our standard, predictable response. The moral: have empathy for the handicapped. We didn't.

The Leaders gave a number of useful hints for survival. 1: Greet the students at the door as they come in to help establish a bit of a personal bond. 2: Throughout the period, keep the door open so that the students know their noise will be heard in the hall. 3: If a student is disruptive, casually walk around the room, innocently and silently approaching and towering over that student, without making eye contact or any direct reference. That assumed, of course, that the disruptive student will be seated. (The Education Empire has created a name for this technique, *Proximity Control*.) Finally, 4: have an emergency kit of activities and supplies ready in case the regular teacher has not left guidelines for the day. (This one I really took to heart but found that the absent teachers were incredibly responsible, coming in to provide lesson plans and assignments even if they were suffering from terminal cancer or midway on a voyage to Mars!)

To further inform us how to handle behavior problems and other emergencies, the Dean of San Mateo High made a guest appearance, and

scared the wits out of all of us. He RADIATED AUTHORITY. His was clearly a good high school to work in. With such a tough dean, any student who even dreamed of getting a single toenail out of line was clipped at the moment of the dream's conception. And indeed, it turned out that the students in San Mateo High were on average the most respectful. They certainly were the least rich, least privileged, and least spoiled.

I did not like one point the Dean of Death insisted on. "Don't send me your problems!" Had I enough time to formulate a response, I should have said to him, "[No, we'll send you your problems.](#)" After all, what the hell is he there for? It took me some time to override his command at any of the three schools. Even though I had virtually no discipline problems in 42 years of college teaching (but did on some occasions when I gave talks to younger children), I am experienced enough to recognize when I have either lost or never had control, and those are exactly the times that I or any Sub should be free to call the Dean. It is the Dean's responsibility to handle those infrequent situations. Any Sub who is wont to lose control should not be called back. Finally, to be fair to the Dean of Death, he did encourage Subs to call him if a student had brought a semiautomatic firearm or machete to class – but only after the student had used it.

Teachers in San Mateo County schools who miss class are required whenever possible to make life easy for the Sub by producing a lesson plan with activities for the students. As I pointed out, the teachers are very responsible this way. The kids know what they have to do and within bounds follow instructions. Unfortunately, with the major exception of Math, all too often, the task for the day is to watch a video that takes up the entire period except perhaps for the few minutes needed to take attendance and possibly answer some simple questions. The end result is that the Subs need not, and often do not have a scintilla of knowledge of the subjects for the classes they are taking over. It is quite possible for a Sub who has forgotten how to add to take over a Calculus class, a Sub who is tone deaf to take over a Music class, or a Sub who is a monolingual mute to take over a foreign language class. I do not know how other Subs feel, but I certainly did not take the job to fill such an inert role. In each period in each day that I subbed I determined to add a little something of value, as I describe in this essay.

As a result, I ruled out subbing in any foreign language except Spanish, which I know somewhat. I eliminated Music even though I play the piano reasonably well because I had not isolated the elements, did not know the theory or terminology (e. g., diminished seventh, tonic, submoric), had no repertoire memorized and, because I hit too many

clinkers and hunt and peck too much when I play by ear. I also eliminated Art from consideration even though I wrote a book on the history of how artists have painted the sky, again because I have not isolated the elements. As a result, my drawings are infantile and all that I can paint with modest competence are walls. I would be willing to be a Sub in Art History or Music Appreciation, but it is seldom possible to find out the course curriculum or even the topic of the day from the Sub List.

Finally, I absolutely and irretrievably ruled out subbing in any Special Ed class, though I did get conned into a few that were unannounced. Once upon a time the word, 'Special' carried a good connotation in the English language. Now it certainly does not when it is used as a prefix to Education or Olympics. In these contexts at least, the word, Special denotes inferior, or limited. No Educator can say this and expect to survive, but the Special Ed students are the academic dummies and quite often, the emotionally disturbed and disturbing monsters. Does this sound harsh and inhumane to you? Let me qualify and soften it.

Meet many Special Ed kids outside the classroom and they may both seem and be quite intelligent. A young cousin had problems with and disliked the academic program. But at her Bat Mitzvah, where she performed beautifully, she saw instantly when another older cousin had no idea of what to do up on the dais. She immediately and subtly intervened in such a way that smoothly covered his ignorance. A seasoned diplomat could not have done any better.

But in the academic classes the Special Ed students are not bright. Most have lost the academic race long before reaching high school. The race starts at birth, if not before. As infants, babies, toddlers and preschoolers, some of them heard too few words and even fewer good words in their homes. They faced a world of barriers by the luck of the draw. If any rescue is possible it must be done long, long before high school. This is an eternal problem that no society, let alone a hostilely heterogeneous one such as is the USA, has ever adequately solved. Playing the humiliating game of "You'll catch up" in high school is the same counterproductive charade that the Soviet Union played on its beleaguered citizens for decades until it collapsed.

Neurologists now link some learning disabilities to faulty circuitry or functioning in the brain. This is an extremely intriguing young field of science. However, because we cannot yet change that circuitry, even if we are getting closer to the roots of learning disabilities, no pedagogical magic can do much to overcome them and they remain learning disabilities.

The Education Empire asserts that having high expectations of students will raise and may even revolutionize their performance, all the while steadfastly swelling the massive, interminable, and unproven subkingdom of Special Ed. At the least, they are inconsistent.

In this memoir, I walk the minefields of expectation, motivation, inspiration, attitude, and responsibility, for they represent core issues in education and in human behavior and performance. Expectations *are* important and powerful, but must be balanced by demands, must be realistic, and, certainly, by high school age, when lasting personal attitudes have already formed, must largely come from within. When I was young I almost expected my dog to talk. To my chagrin he did not rise to my expectations. Think my example too cynical? Just see how far high expectations alone get with high school students who are convinced that they stink at math.

An almost insignificant personal anecdote of ‘leader adrenaline’ proved to me the power of attitude. In my last two years as a graduate student I played judo. Every day began with 25 minutes of rigorous warm-up calisthenics including sit-ups and push-ups. Each day, a different member played the role of leader by announcing the exercises and counting out loud while doing them. Since the routine was always the same, I was amazed to find that the one day I led the exercises and did the extra work of counting, was the one day I did not feel tired at the end.

Related to this is a series of studies on the impact of what is called subliminal priming on performance due to stereotype susceptibility. In an oft-cited study in 1999 by Margaret Shih, Todd Pittinsky, and Nalini Ambady, Asian-American women students were divided randomly into three groups. All were given the same math test but two of the groups were ‘primed’ with a subtle message. Group #1 was primed before the test with questions about their Asian identity. Group #2 was primed with questions about their female identity. Group #3 was not primed. Group #1 scored the highest, likely because Asians are thought to be good at math while Group #2 scored the lowest, likely because women are thought to be poor at math.

So, whatever a teacher and administrator can do to improve attitude is vitally important. For starters, teachers must possess sufficient authority to mandate a good work ethic. But no one can perform the impossible. “Its mind over matter” is a beautiful expression, but it works only so long as you have the matter. Just think of chemistry (even aside from Ritalin) and addiction. Good parents of addicted children must make sure they are not enabling their child's habit. They must provide what guidance they can and ensure the child is given professional care. When they have

done all they can, they must recognize that they are not to blame for what is often in good part a biochemical and genetic problem, whose solution hinges on the child's will.

If professionals recognize that some people are chemically addicted, and everyone can recognize that some people are more athletic or more attractive or more intelligent or more social, etc. than others, and not slather on unrealistic and burdensome expectations, why is the Education Empire incapable of or unwilling to do so? Why is it honor bound to remain in denial and replace the real world with the imaginary land of Euphemismia?

Euphemisms abound in the Education Empire, as in the political realm. They are driven by several factors. There is the legitimate wish to eliminate denigration, condemnation and scorn. There is also the baseless ideology that they will be inspirational and the absurd belief, hope, or dogma that no one is inferior (or, by consistency, superior). This drives standards out the window.

There is a sad but true Law of Euphemisms. The connotation of any euphemism will descend to the level for which it was designed. Consider again the word, Special, which was used to mean something good. For example, if I said "I have something Special for you", you would almost surely be happy. But you wouldn't be happy if I told you I had Special Ed for you.

The question of how to apportion educational efforts and funds is much like the question of how to design the economy between the extremes of heartless, efficient capitalism and sympathetic, inefficient socialism. The pedagogical pendulum has swung too far. The unbounded proliferation of Special Ed programs and personnel is an abomination, a counterproductive diversion, and a prohibitively expensive waste of time and resources. In the upscale town where my wife taught, Special Ed consumed a whopping 32% of the school budget for the worst  $\approx 10\%$  of the students, as if it were assumed that the smart kids would take care of themselves (and of the Society when they grow up).

For each certified Special Ed Student it is required to design a personalized IEP (Individual Education Plan). A cadre of teachers, aides and specialists is assigned to monitor and guide the student. A myriad of pedagogical techniques and tricks have been developed to try to rouse interests and enthusiasm in the moribund Special Ed students. Richard Lavoie gives some idea of these in a 400 page compendium, *The Motivation Breakthrough: Six Secrets to Turning on the Tuned-out Child*. They are all fine, admirable techniques but to implement them consistently while teaching a full class exhausts almost all teachers. And even sympathetic devotees acknowledge that too many of the few

apparent successes are as tenuous and short-lived as a house of cards in a gale. Add the riling disturbances caused by ceaseless periodic changes in the Special Ed Philosophy or Approach (which requires changing the IEP's) and it is easier to balance a sharpened pencil on its point than to sharpen a Special Ed student.

One year in my wife's school, Special Ed students, who disparagingly labeled themselves as SPEDS, were taken out of the regular classes, and placed in tiny 'Resource Room' classes, where they spent much of their time taking random mental excursions to some other planet or arguing with the teacher that she had never taught what she had, in fact, repeatedly taught and reviewed. By the day after some concept had been successfully, albeit momentarily, drilled into their heads, it had drained out through the same or some other orifice. When the teacher said, "Let's review Percentages," the standard response was, "You never taught us that!"

The next year the great pendulum of the Education Empire swung to the opposite pole. (Multipolar ideology accompanied by sophisticated sounding but vacuous lingo are among its dominant and most endearing characteristics.) The new idea was, "Taking the SPEDS out of class labels them and damages their egos, so '*Mainstream*' them". Of course, to keep them in order and ensure that they have some rudimentary notion of what is going on so that they don't distract the rest of the students, the SPEDS must be accompanied by an additional teacher or teacher's aide, often one on one. Everything must be previewed, prechewed, and predigested for them. Talk of the problem in Education of teaching to the test; the SPEDS were virtually given not only the questions on the test but also the answers to the test before the test. And still, they managed to screw up. And still, they were disparagingly labeled mainly by themselves as SPEDS. Their damaged egos suffered no additional loss by being mainstreamed though they slowed the rest of the class; neither did it improve one iota. What in the world are our schools doing (and mandated to do)?

Every day and every minute of every day, the Education Empire must renew its fundamental decision to choose technique over substance. Mathematicians have the handle on Math, Physicists on Physics, Musicians on Music, and so on. So what is left to the Education 'Experts'? You got it – technique, sometimes called Pedagogy. By the way, the etymology of pedagogue is slave! Everyone knows that there are good teachers and bad teachers. The formula for great teaching is elusive even though we know some of its ingredients (see Day #18). But the Education Empire has become in too many ways a self-sustaining tyranny that all too often burdens the teachers it is supposed to help and

the students it is supposed to educate. And what progress in learning can it honestly report? Here is a typical sequence of meddling by the Education Empire (EE). Call me cynic, but I defy you to prove it wrong.

1. EE finds a problem with student performance.
2. EE imposes a 'revolutionary', lingo-laden, pedagogical panacea.
3. EE orders new textbooks and materials and trashes the old.
4. EE rates resistant (i. e., high salaried) teachers ineffective
5. Under pressure from EE resistant teachers retire en masse.
6. EE proclaims major preliminary advances in student performance.
7. A multi-year statistical study reveals no changes in performance.
8. EE blames the failure on inadequate training and resistance.
9. EE quietly recycles the old teaching methods, with new names.
10. EE orders new texts and materials and trashes the old.

Some of the time it appears as if Education Administrators have nothing to do but create Entropy. The rest of the time you realize the appearance is accurate.

One current fad used to straitjacket teachers and crush them under an absurd mass of paperwork is the holy 'Rubric' (defined as "a standard of performance for a defined population"), whose etymology involves the color red, presumably for red pens used in highlighting, but more likely for bloodletting. I began hearing this word about the year, 2000 and it took me about 5 years to cross the Rubric Con and begin to understand it and its rubri-fications. For each course, we were ordered to design lengthy rubrics, which called for listing the main topics, expostulating on the purpose for including them, their relevance, the goals for the course and for each topic in the course, the expected outcomes (how expected outcomes differs from the goals I don't know unless you fail in your goals), etc.

The classic Course Catalog description, which contains a brief list of the topics covered in each course, was deemed unacceptable for reasons I found incomprehensible (but probably because it is short and to the point). This left me perplexed. For example, every weather course describes storms, and course catalogs list these. But how do you answer ridiculous questions such as "Why are storms included in a weather course? How are they relevant to weather? What is the goal of teaching storms in a weather course?" It is as if we have to explain why each different body part is included in a course on Anatomy and why we consider the eye or the heart relevant and what is the goal of teaching about the brain. In a course of 19<sup>th</sup> Century American Literature it might be useful to explain why you would choose to include one particular

book, such as *Moby Dick*, over another, such as *The Scarlett Letter*, but that is largely a case establishing priority or emphasis where material is too voluminous.

The gargantuan rubrics assume and almost impose on students no insight, no motivation, no initiative, and no intelligence. Administrators read the rubrics only to latch onto some flimsy ground to criticize and condemn the teacher or department in good part to cut school budgets. After all, many principals and superintendents are now hired to cut budgets. They can do this easily by capitalizing on the fatal flaw in the seniority system that the unions imposed, namely pay senior teachers triple what new teachers earn. They simply execute the not so secret order in the administrator's handbook – "Pressure the expensive senior teachers to retire by giving them dismal reviews, while steadfastly denying that budget cutting was the motive in each case, though acknowledging financial motives in general."

Well-done rubrics provide potentially good templates for evaluation, but are now imposed to compel teachers and administrators to waste time and effort justifying what they are teaching, how they are teaching, what its purpose is, what its significance is, how they are going to evaluate its effectiveness (evaluation is always problematic, often elusive and almost invariably fabricated), how they are involving students, how they are relating to the students, etc.

These criteria are perfectly designed to fit into an Excel Spreadsheet. And fit they barely do because Excel 2013 has only been expanded to 1,048,576 rows by 16,384 columns. The *Danielson Rubric*, originally designed as a helpful guide for Elementary School teachers, has been bloated, exported outside its zone of relevance, and transmogrified by the New York State Department of Education among other parts of the Education Empire into a time and energy consuming straitjacket that mandates misery in teachers' lives.

Good technique is commendable until it become so overbearing that it squelches initiative, spontaneity, and creativity. A charming example of the limitations of technique is dramatized in the 1960 film, *School for Scoundrels*. The hero, who is wealthy but is gulled and conned by everyone, falls in love with a young lady, and quickly loses her to a 'friend'. The hero then finds the "School of Lifemanship". There he is taught the techniques of getting one up on everyone. But in the end, it is his love that wins the girl his techniques would have lost. And his professor's lament, "...Once sincerity rears its ugly head, well, Lifemanship is powerless", applies without modification to pedagogical techniques.

With the above quote in mind, return to the Danielson Rubric. The spreadsheet in the 2013 Version has spread to 109 pages. I dare you to even skim it all, let alone implement it in class. Even if every instruction were golden, how could they all be implemented, and simultaneously at that, in every 45 or 50 minute class period?

For example, here are 3 of the merely 92 bulleted points that the distinguished teacher must satisfy each class period every day.

- The teacher uses ongoing [whatever that means] methods to assess students' skill levels and designs instruction accordingly.
- The teacher seeks out information from all students about their cultural heritages.
- The teacher maintains a system of updated student records and incorporates medical and/or learning needs into lesson plans.

Sounds really impressive and extremely admirable, doesn't it! And indeed, most of these standards have great virtue – in their proper place. For example, at CCNY, students in my Hydrology and Climatology classes came from all over the world. Each region had distinct water or climate related resources and limitations. Each experience was valued and valuable, and added to the quality, enjoyment, and ultimately the performance in these classes.

But rigidly indiscriminant enforcement of these standards, which is what happens when the Education Empire takes over, is troublesome. You might well suspect that Danielson's Rubric, originally designed for Grade School, has been inappropriately patched upward to High School without much thought or modification. I will ask one question about each of the three bulleted points stated above.

- Do we teach Ampere's Law differently to a student who lacks the abilities to grasp the right hand rule and calculate the magnetic field?
- Does cultural heritage make the value of  $\pi$  different in China than in Brazil?
- Does the teacher adapt the lesson plan on the pH and pK of acids and bases to enable 7 students, each with a different form of ADHD [Attention Deficit Hyperactivity Disorder]?

While we are on the subject of students' learning needs, let's touch on the matter of how the Education Empire treats the students' varied talents and abilities it does acknowledge. We are told by some scholars, such as Howard Gardner, that there are 9 different types of intelligence. Wow! This is a formalization of the almost universally accepted, ancient idea

that different people have different talents or abilities. (Even animals recognize differences of strength, etc., in their peers.) However, the word, intelligence was used, most likely because of its snob appeal. Before seeing how the Education Empire uses this knowledge I'll run through the list, taken from: *Overview of the Multiple Intelligences Theory* Association for Supervision and Curriculum Development and Thomas Armstrong.com.

1. **Naturalist Intelligence** (“Nature Smart”): The ability to discriminate among living things (plants, animals) as well as sensitivity to other features of the natural world (clouds, rocks).
2. **Musical Intelligence** (“Music Smart”): The capacity to discern pitch, rhythm, timbre, and tone. There is often an affective connection between music and the emotions; and mathematical and musical intelligences may share common thinking processes.
3. **Logical-Mathematical Intelligence** (Number/Reasoning Smart): The ability to calculate, quantify, consider propositions and hypotheses, and carry out complete mathematical operations. It enables us to perceive relationships and connections and to use abstract, symbolic thought; sequential reasoning skills; and inductive and deductive thinking patterns.
4. **Existential Intelligence**: (“Soul Smart”): Sensitivity and capacity to tackle deep questions about human existence, such as the meaning of life, why do we die, and how did we get here.
5. **Interpersonal Intelligence** (People Smart”): The ability to understand and interact effectively with others. It involves effective verbal and nonverbal communication, the ability to note distinctions among others, sensitivity to the moods and temperaments of others, and the ability to entertain multiple perspectives.
6. **Bodily-Kinesthetic Intelligence** (“Body Smart”): The capacity to manipulate objects and use a variety of physical skills. This intelligence also involves a sense of timing and the perfection of skills through mind–body union.
7. **Linguistic Intelligence** (Word Smart): The ability to think in words and to use language to express and appreciate complex meanings.
8. **Intra-personal Intelligence** (Self Smart”): The capacity to understand oneself and one’s thoughts and feelings, and to use such knowledge in planning and directing one’s life. It involves not only an appreciation of the self, but also of the human condition.
9. **Spatial Intelligence** (“Picture Smart”): The ability to think in three dimensions. Core capacities include mental imagery, spatial

reasoning, image manipulation, graphic and artistic skills, and an active imagination.

Each of us has all these talents or abilities to one degree or another. With some of us one particular talent is developed to a profound degree while other talents may be almost absent. These are the specialists, the aficionados, the savants! By the way, note the conspicuous omission of **Humor Intelligence**, also ignored by the Oscars or Academy Awards, where men winners tend to play martyrs and women winners tend to play reformed, reluctant, or tragic prostitutes. Perhaps the lack of Humor Intelligence is one of the causes of failure in education. You might conclude that Howard Gardner and his followers lack humor. You might be right.

Upon recognizing the different talents or intelligences, you would think that the Education Empire would direct students to the areas where they have talents and loves and away from the areas where they are lacking, where they have repeatedly failed or performed dismally, and which they hate. Think again! To the extent that the theory of Multiple Intelligences is accepted by the Education Empire, it impacts technique almost exclusively and downplays or ignores subject. Our society is technologically driven. Who are we to deny anyone the opportunity to rise to the top of the techie tree? So, students with nary a scintilla of Logical-Mathematical Intelligence but a high Musical Intelligence are still crammed into higher math classes.

The absurd idea proffered by the Education Empire is that anyone will conquer any subject if they are taught using their particular intelligences. There are merits, great merits indeed, in variations of teaching techniques in any subject, but let's take an extreme example to illustrate what nonsense is foisted on us. Suppose we insist on teaching running to a whale by using its swimming intelligence. All we will do is get the whale beached and dead.

So, the math teacher is mandated to reach the highly talented musical but mathematically 'challenged' students through some 'revolutionary' new approach to math such as by singing equations. Give me a break! Give the teacher a break! Most of all, give those students a break! Quickly tell and briefly show them that music has rhythm and harmony, and that rhythm and harmony have numbers and patterns and let it go at that. Free them from the remedial (and too often repeated) advanced math class where they suffer under an interminable sentence. Instead, get them into a music class where they and everyone else will be happier and will benefit. How many Beethovens have we lost in the fruitless mission

to engineer and redesign them into Einsteins? If later in life they find they love a subject they once hated they can learn it then.

What it gets down to is that while spuriously praising diversity, the Education Empire continues to strap students and teachers onto Procrustean Beds of exacting conformity, to the detriment of the entire society. In the illusory hope of finding one lottery winner, they condemn armies of students who simply lack the ability or inclination to succeed in an academic program.

Look at small children. They do not live in the adult world but become very smart very fast. Provided that they have not been damaged in their earliest years by harmful parents, their drive, their enthusiasm, their talents, their pliability, their knowledge, their intelligence, and yes, their wisdom is admirable to the point of wonder. But imposing on them the things they are not ready to do, such as trying to make them read at the age of 2, is a waste of time and, what is worse, counterproductive. As they grow and develop, some of these abilities emerge in full bloom, others in partial measure and some simply do not. We want their education to be one that allows and encourages all their potentialities and *realistic* wishes; we certainly do not want their schooling to be a lifetime of degradation by compelling them to try to do what they are simply incapable of, or, for that matter, hate. Think! The etymology of school is leisure!!!

There is another issue involving the Education Empire that deserves at least a paragraph. Consider the Common Core. In principle, it is a good idea to have some standard curricula across the nation. It can be a goal, not a strait jacket. Of course, infighting and controversy helped cloud that issue and rouse the knee jerk, clarion call of states rights that stifles all rational discourse.

But I must have been purblind despite all my cynicism to what is almost surely a central branch of the Education Empire. A revolutionary new curriculum mandates fresh, new texts and materials. Trash all the hundreds of millions of existing, old, irrelevant, bloated texts, and in their place, print up fresh, new bloated, prohibitively profitable texts. So, can you guess the branch of the Education Empire most firmly advocating for the Common Core? You got it – The Text Book Publishers! The billions they have already made promulgating their ‘educational revolution’ is just the start. Clearly, money talks, and we all know what walks.

Enough of these diversions and premonitions; I was now ready for...

## **Day #1: Battlefield Survivor: Guide on the Side vs. Sage on the Stage**

How do Subs get the call? Subs in San Mateo County are informed about available teaching assignments by telephone or by logging into the Automated Educational Substitute Operator (AESOP) System on the Internet. Someone had to waste months of silly labor to produce this acronym. You have to ask, “Do acronyms save time when you include all the time devoted to inventing them and the even greater time needed to look back to see what they mean?”

Don’t look back! – I bet you have already forgotten or simply skipped over what the acronym AESOP stands for! The AESOP system lists available subbing jobs each day. It enables a teacher to leave notes or assignments for the Sub, though few ever do. The Sub gets them upon arrival in the classroom.

In addition to the restricted list of subjects I would sub in (see p. 23), I only accepted offers from the 3 high schools within walking distance of my apartment – 1.0 mile to Aragon High, 1.5 miles to San Mateo High, and 2.9 miles to Hillsdale High. One evening, even before the final paperwork came through, I got my first call, logged onto my AESOP Account and accepted my assignment at San Mateo High.

I fell asleep nervous and awoke nervous. After 42 years of teaching in college, I was headed for the first time to take over several high school classes as a total unknown in some unknown topics in a school whose layout was unknown to me. My nervousness was due to three factors,

1. My nature,
2. A common human feeling on the first day of any new activity, and
3. A foreboding backed by experience that Subs have no authority.

Since then, there hasn’t been a single day that I accepted an assignment to substitute, that I haven’t had at least a nervous twinge before the first class. If you get a critical mass of bad students, there is little you can do. It’s the luck of the draw. Nervousness is the attempt by the mind to control the random events of fate. It is an atavistic alerting system that may do some good but surely feels very bad. It is most likely counterproductive because, among other factors, students, like all humans, inevitably pick up body language. I am sorry to say it, but nervousness is a drag I still contend with. I don’t know how many other Subs feel it.

I had prepared somewhat for the first day, assembling a package including supplies (pencils, erasers, rulers, a calculator, magnets, coins to

flip for probability, a protractor, one compass to draw circles and one to determine direction, and a laser pointer), equipment for simple demonstrations, and some math games and brain teasers. I took a book on First Aid because I thought from the abbreviation in the AESOP System that the assigned subject was Health Science, which turned out not to be the case. But my best preparation was the previous 52 years of learning at and above the high school level.

We were advised to arrive about 15 minutes early (at 07:30), so I did. No one else was there, of course, so I had to wait about 15 minutes. When the Administrative Assistant arrived and got settled, she gave me my teaching assignment for the day – two double or block period classes of history plus a study hall. This came with room keys, a package of instructions for emergencies such as fire and earthquakes, and a map of the school. I was directed to my classroom of the day and shown where the library is. Using the map on my own I found the faculty rest room. Reading maps has been one of my specialties.

Upon entering the classroom I was shocked by the arrangement of the chairs. They were separated into two equal groups facing sideways toward a center aisle. All students would have to turn their heads 90° to see their teacher in the front of the room. This arrangement seemed insane to me, surely more appropriate for two warring armies than a class of students who might be able to learn something from their teacher. Because this arrangement is popular in two of the three high schools in San Mateo I conclude that it is the result of some trendy and misbegotten (again, please forgive me for being redundant!) pedagogical theory.

No more "Sage on the Stage". That model of education has gone out the window in favor of, I kid you not, the "Guide on the Side". But considering that the room had no space on the sides I concluded that the teacher might have been aiming at a revolutionary new model of "Mentor in the Center". What do you think these rhyming ditties add to learning? Nada! What do you think the educational model on which they are based adds to learning? Less than nada! One recent study showed that increasing lecture time in math led to a slight increase in test scores for all students and a somewhat greater increase for the better students. Teachers must be allowed to transmit their expertise and knowledge to the students.

The seating arrangement (and education model) was certainly different from that in my old high school. There, individual or group desks, often with prehistoric, petrified inkwells, were more likely riveted to the floor facing the front of the room. It also seemed that many of the teachers were riveted to the floor, and some were prehistoric. The

currently mocked sage on the stage model of teaching was then the standard and sole vogue.

What it gets down to is that students will certainly be inspired more by an inspired teacher, no matter what the exact approach, and they will learn more and better when they work more and better. But I am talking reality now.

Regarding the advice to keep the door open, there was no doorstop and no movable trash basket, so the door, which had a strong spring, remained shut. The department chairwoman walked in to make sure I was alive, and then I was left alone. I managed to find two faint, almost dried out markers, wrote my name on the white board, prefixed with the title, Dr., and awaited the arrival of the students.

Each period is supposed to begin by taking attendance. While taking attendance I asked the students to write a paragraph on whether students treat Subs better or worse than they treat their regular teacher and then give reasons. Students' answers were insightful and to the point. This I have found to be almost universally the case. When students are asked their personal opinion, many give really sincere, beautiful and touching responses. By the way, any time I gave a survey in the 'bad' classes, numerous students asked to borrow pens or pencils and paper. They are seldom prepared. The time they waste is enough to build pyramids and dismantle civilization.

For this essay, the students noted that Subs usually get poorer treatment because they lack power and authority, but it depends on the

1. Student – students who are serious about learning are less abusive.
2. Regular teacher – his or her skill and discipline imposed in class.
3. Sub.

Any Sub who displays knowledge and seems to be in command gets better treatment. Subs who try to be too harsh or too strict will appear weak and thereby render themselves vulnerable, and easy, deliciously tempting targets for abuse.

One hint in violation of official protocol is to take attendance later in each period so that the Sub can identify problem students by name. But that occurred to me much later. One Sub told me that he scopes out potential problem students at the start and makes it a point to remember or list their names and call on them by name. Addressing anyone by name puts them in listening mode. Many teachers have a seating plan, which helps if the students sit in the right place when the Sub is there. Students do have a curious tendency to migrate when the Customs Official (i. e., their regular teacher) is absent.

The Sub's next official act is to hand out the assignment. But the experienced Subs of Day #0 recommended that you introduce yourself to let the students know who you are and give everyone a chance to bond even though acting like their friend is more likely a kiss of death.

I took to heart the hint about bonding. Because I had undergone a second surgery to repair a detached retina only a month earlier (on 9/11; my first surgery was the day after July 4), I wore a black eye patch. This distinctive badge called for an explanation, given that several students dubbed me 'Pirate'. So, after briefly describing a few highlights from my former career, I gave a short lecture on how the eye works, what happened to my eye, and what the surgery involved.

I drew a circular cross section of the eye showing the pupil in the front or outside, the retina with its rods and cones in the back, and the optic nerve leading to the brain. I showed the class how rays of light entering the eye lead to the eye recording images up-side-down, as does a camera, and then pointed out that babies see inverted images for the first few weeks of their life until they learn to process everything right-side-up. My retina operation required removing the vitreous humor, the transparent Jell-O-like substance of the eye, and replacing it with a bubble of nitrogen gas. Over the succeeding weeks the bubble gradually shrinks as it is reabsorbed and replaced by liquid. The bubble floats to the top of the eyeball, but appears at the bottom of the field of vision. I also let them know that the idea was to smooth the crumpled retina, a job much like smoothing a crumpled piece of paper. My vision would never again be good.

Thus, there was educational impact and value to my introduction and misfortune. Students came away with some knowledge of how the eye works and how we see. Some students were visibly queasy when I said that a needle was inserted into my eyeball, but my tale held everyone's attention. I also linked the bubble's inverted appearance at the bottom of my field of vision to lack of objectivity in matters of political and religious preference. In the days before the election of 2012, with all the strident and polarized opinions that filled the Media and indicated mass detachment from objective reality, the inversion of reality in my eye made for a timely analogy in literature and social studies, as well as being a timeless analogy in physics and optics.

In the days just before and the weeks after Hurricane Sandy's landfall on 29 October 2012, I spoke about the storm.

I taught at CCNY for years about the precise combination of events needed to produce the worst case scenario for a hurricane on the New York-New Jersey Coast. I waited, hoping it would happen when I was

teaching, but Hurricane Sandy didn't come until the year after I retired. The conditions are,

1. The Hurricane must remain over the sea as long as possible because Hurricanes are steam engines that derive their energy from warm water, and rapidly die over land.
2. It must strike at high tide to maximize flooding along the coast.
3. It must turn to the west and move inland over New Jersey, just south of New York City to produce the maximum rise of waters to flood coastal areas and the vulnerable subway system. Turning to the west at the right time and location requires that
4. Cold air must invade the Southeast USA when the hurricane approaches the New York area because storms move by keeping cold air to their left.

From the map I just drew on the board you can start to see how perfectly Sandy met the criteria. Most hurricanes pass out to sea (toward the east) because cold air is usually centered to the north in Canada. But just as Sandy moved up the coast, by coincidence, Sandy's counterclockwise winds helped to draw the cold air southward. This forced Sandy to make its rather abrupt turn to the west and smash into New Jersey.

The whole ocean around New York and New Jersey rose. How does the storm lift the ocean? The storm's low pressure acts like a person lifting a drink through a straw by sucking on it and lowering air pressure in the straw. A strong wind blowing into a narrowing coast such as New York Harbor lifted the water even more and raised huge waves to boot. Add to this the storm's arrival at the time of High Tide at the Full Moon, and the coastal scenario was complete. Inland, gale force winds for over 12 hours, combined with soaking rain, turned the soil to mud toppling millions of trees, blocking roads and knocking out power for days. A final costly irony occurred in Breezy Point, NY, where flooding kept Fireman from putting out an inferno that incinerated over 100 of their own homes, because this is precisely where many Firemen live.

That description took just me about as long to say to the classes as it took you to read. With less than 20 minutes taken up from the start of the double block-period class for all the preliminaries, we were now ready for the day's assignment. I was to accompany the students to the computer room in the library, where they were to research on the Internet the Propositions on the 2012 California ballot.

The students worked in groups with appallingly low efficiency for the most part. Many students were far more concerned with the font and

color of their presentations than the content – that is, when they weren't looking up the latest sagas of their favorite MTV stars or sports heroes. When they did turn back to the assignment, most were content to copy from anyone in their group who happened to get any iota of an idea. And I am speaking of the better students in the class; the poorer students wasted time even more egregiously by blundering over a previous, overdue project they had failed to complete on time.

One young lady simply refused to do any work, reading a novel with a brazen, attention demanding display of silent defiance. I passed by her terminal with an equally ostentatious silent show of unawareness, making no attempt to challenge her, which caused her obvious disappointment. I do regret not having confronted her gently by telling her exactly what I saw and asking her why she acted that way. But I didn't. And since the students' noise level remained tolerable, the class was a success from that point of view, but I had added almost nothing.

The second class consisted of 9<sup>th</sup> graders. Many 9<sup>th</sup> graders are still getting used to the idea that High School means business. Those who are a bit behind in physical development also tend to be a bit behind emotionally. They embodied exactly what and who I did not want to teach – adolescents.

The assignment centered around an interminable documentary video on the lives of people in a Mexican town, most of whose men had left and were living and working illegally in the United States. The assignment was to write their opinions about illegal immigration both before and after watching. I presume that the purpose of the exercise was to reduce prejudice. The students did the initial survey with decorum but became edgy during the long video despite its subtitles because it was in Spanish, which many of them did not know.

One boy spent almost the entire time looking back at a friend and giggling. I used the recommended technique (from Day #0) of walking over and standing between them. It worked! The kid turned back looking totally deflated and placed his head on his desk. But while my attentions were so occupied on one side of the battlefield seating arrangement, a new uprising arose spontaneously on the other side. It brought to mind the game, *Whack a Mole*, where moles, like extremism, rise up somewhere in a grid and have to be knocked down, only to arise somewhere else. And in the class, as in the game, the pop-up rate for the moles increases to the point that you, the whacker, are eventually overwhelmed and lose the game. Long before the video ended the kids were so jittery and their brains so fried that not one of them could do the post video survey.

My most successful class that day was Study Hall, if you don't count the scintillating time I spent in the Rest Room. But I had survived to fight another day.

## Day #2: Beginning to Contribute in History

The classroom had a conventional seating arrangement, but it didn't matter because all classes had to do their work in the computer room of the library. That was lucky because their classroom was a mess. The teacher's desk was full of empty soda bottles. It was clear that she was a disorganized clutterer. Disorganization by itself doesn't make a bad teacher, for it may be connected with inspiration, but inspiration also seemed to be lacking. The students were not unhappy to be rid of her for a day and not just because of the extra freedom.

The subject was Modern World History. I asked the class what historical event they were studying. They all seemed to know it was the French Revolution. When I asked what year the French Revolution began, only one student knew (or admitted to knowing) it, and most had no idea of the century. I then asked with what historical period or event did the course begin. Most students either didn't remember or didn't know that it was the Renaissance. They also didn't know in what century the Renaissance occurred.

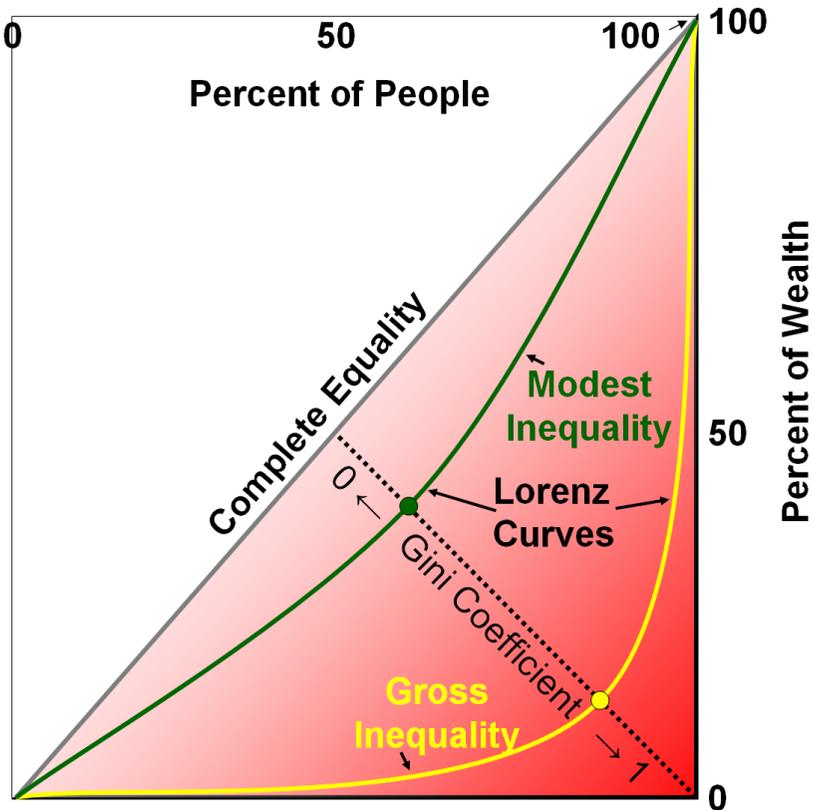
We all remember the universal complaint that history as taught in school seems to consist only of dates. That, of course, is a stereotypical criticism with only partial validity. For, the one student who knew the year the French Revolution began also was one of the few who knew that it followed soon after the American Revolution, and was inspired by it.

Dates do matter! They help to fix sequences and possibly cause and effect. I concluded the questioning on dates by asking them in what year they were born. Somehow, each knew that year and confessed they found it to be quite relevant and important.

After this short introduction, we left for the computer room. The assignment was to compare the present distribution of wealth in the USA to that in France just before the French Revolution, and then comment on whether Revolution seems a likely possibility in the USA today. The web site the teacher gave showed a pie graph of wealth distribution. One goal of the assignment was to reinforce students' graph reading skills. But a pie graph is a crude, semi-quantitative tool at best. It is something a 2-year old can easily understand. Try it! Show any 2-year old a pie they love that you have divided into different size slices and offer them the smallest slice. After they stop screaming, ask them which slice they want. They will choose the largest slice even if they can't finish  $\frac{1}{4}$  of it.

So, I took away my students' pie and began to make a significant input. I remembered the *Lorenz Curve* and *Gini Coefficient* (though I had forgotten the name, Gini), which provide more detailed quantitative measures of wealth distribution. If the Gini Coefficient is 0 then

everyone's wealth is equal; that is represented by the diagonal Line of Equality in Figure 2. If the Gini Coefficient is 1 (represented by the two axes) then one person has all the wealth and everyone else has nothing. The typical Lorenz curve lies somewhere between the two extremes, and the lower and closer it is to the axes the more *inequitable* the distribution of wealth. The articles I found on the Web gave the present Gini Coefficients of many of the world's nations as well as of France during the 18<sup>th</sup> and 19<sup>th</sup> centuries. One article related the Lorenz Curve and Gini Coefficient to the Pareto Principle, which states that roughly 20% of the people do 80% of the work, or 20% of customers account for 80% of a merchant's profits or that 20% of the students make 80% of the complaints.



**Fig. 2. Lorenz Curves and Gini Coefficients for distribution of wealth. Green Curve = Bottom 60% has 40% of wealth. Yellow Curve = Bottom 85% has 15% of wealth.**

I chose to walk around the room and quietly inform groups of 3 or 4 students at a time about these findings. The students in each group felt that they were getting special, almost secret information. Here, the Sub has a distinct advantage over the regular teacher. I was breaking a boring, senseless and repressive rule – a favorite pastime or wish of teenagers. That made it more fun. All appeared very interested and highly receptive to the information delivered in such a personal manner. When one student from another group tried to interject himself, I told him that I would get to his group soon. The group I was sitting with at that moment gladly excluded him and redoubled their attention to prove to the outsider that he did not belong.

But technique alone is an empty shell, a skeleton. It can only be filled and given muscle and flesh by substance. It resonated with the students that of all the countries in the world with relevant data, the country with the highest Gini Coefficient (64%) is South Africa, the lowest (23.0%) is Sweden and that the USA has a pretty high Gini Coefficient (45%), almost exactly the same that France did just before the French Revolution. I think they were glad to learn something relevant and important and that showed them capable of understanding conceptual material much more intricate than a moronic pie chart.

### Day #3: Surviving Remedial Geometry and Sinking in Titanic Texts

This was the first time I subbed in Math. Period #1 was a free Prep period, so I looked at the text for the next period's class, Remedial Geometry. After using a crane to hoist the 1200 page textbook, I could not make heads or tails of it. Most current textbooks read like lightning bolts prior to reaching the ground. Lost leaders dart all over the place long before striking the ground at some completely unpredictable point. I'd rather have shock therapy than be forced to learn from such monstrous volumes. They are filled with distractions misnamed 'Focus Boxes' and gorged to avoid omitting an iota of material any school board in the universe might deem indispensable. By Day #7, when I saw the same Promethean Amusement Park of Distractions in the unfocused, bloated Political Science textbook, I came to realize what chaotic and scatter-brained fluff students put up with in almost every subject. It's no wonder most students don't read their textbooks! (Don't take my harsh words as a criticism of textbook authors, but rather of the insane specifications and contradictory requirements placed on them if they hope to sell their wares.)

By contrast, the GRE Guide was succinct. Any student would be wise to toss their titanic texts on the nearest iceberg on the first day of school to avoid sinking themselves. But how can we prevent the students from tearing their muscles heaving such heavy weights? Thank God for gym! Not only does it get you in shape to throw out useless texts, it is itself free of texts – so far.

One further 'virtue' of these textbooks is that they are designed to further reduce the students' minute attention spans and already compromised abilities to concentrate, which are tenors of the times. In this regard they are more effective than electroshock therapy. People are so distracted now that the definition of multitasking must be upgraded to "doing at least 3 things simultaneously without realizing that you are attempting to do the fourth thing". Movies and TV contribute greatly to this curse. Just count how many scenes flash before your eyes in one minute. The average is 60, and is considerably greater for advertisements! And, with a few noble exceptions (such as *The King's Speech*), movies make it seem that major accomplishments are achieved almost instantly with little or no effort (just genius). A typical example is the computer nerd who breaks into and deciphers some code of prodigious length and complexity that took hundreds or thousands of programmers years to construct and that makes *War and Peace* seem as short as the *Gettysburg Address*. Within 30 seconds the nerd finds the

exact line where the code has been sabotaged and, in the next 4.3 seconds, reverses all the damage, just before a deadline that will blow up the planet. Students today are far better at multitasking and at finding some source material on the Web than previous generations, but what they have gained cannot compensate for their loss of focus and concentration.

Back to the class! Sorry, I got distracted, but after all, that is one of the marks of the times. Having been confused by the text and needing time to recall the approach and lingo of geometry, with its axioms, postulates, theorems, transitive and reflexive properties, identities, etc., I was totally lost and extremely thankful that the class had a Special Ed Assistant Teacher who actually knew the math. She was my salvation. Without her it would have been a disaster. I gratefully allowed her to begin the class. When my confidence resurged about 15 minutes later I began a tiny lecture. Huge Mistake! I totally lost the students in the time it would take you to say "uh". If the SPEDS lose their train of thought for a nanosecond, especially in math, they give up utterly, and instantly become rowdy. The Assistant Teacher relieved me and gave me time to recover. The period ended, my assistant and lifesaver smiled and left for her next war zone.

The next period had "normal" kids. I made it through their math class, slowly feeling my way without incident or distinction. But I did start one new thing.

While taking attendance I gave the students a survey with the following directions. "Rate how you like math on a scale from 0 to 10!" One instant response was, "How about minus infinity?" This was a wise guy question I had both anticipated and appreciated (as did the entire class) for its high level of mathematical sophistication. I calmly countered that "0 on my scale corresponds to Absolutely Hate, 5 to Neutral and 10 to Absolutely Love", and made sure to define that scale from the get-go whenever I subsequently gave that survey. Then I added, "After giving your rating, give me the reason for your choice in a few sentences." I had to remind them, "Do not consult your neighbors since I want you to make up your minds on your own."

I repeated this survey in almost every math class I subbed in for the next year. The most common choice is 5 (neutral) with the most common comment being, "I sort of like it but sometimes it gets hard and then I don't like it when I don't understand it." So you can tell what the reasons would be from students who give math 0 to 3. "I don't understand it. I am lost." Some of them added the standard but terribly wrong comment that it is not relevant to their lives. Most students who give it 7 to 10 typically write, "I like Math because it is easy to me." Only a few students give

carefully thought out reasons. One sophomore rhapsodized on the beauty of math, its order, its perfection, and its applicability to everything. I was touched by his eloquence and passion, and told him so. Here is what he wrote.

"I honestly love math. I love learning it, I love applying it. And damn, is it applicable! My number 1 current interest is digital art. I use math all the time in that and in every other field. Math is the way to think. Any hard task involves thinking, and math skills will always help achieve your life goals. I feel like most people who know me would be somewhat surprised by my answer of a 10 but the fact is I do, very much. There is a particular beauty, the most basic beauty, in the surprising and epiphany [sic] patterns of math. Amazing!"

This guy really got it. Math is the language of pattern and pattern is an underpinning of beauty. The logical skills you develop through Math can help solve problems in diverse fields, and perhaps even some life and economic problems. (Of course, not everyone feels that way.)

As an example, consider the book, *Math through the Ages: A Gentle History for Teachers and Others*. William Berlinghoff and Fernando Gouvêa show how the *Declaration of Independence* was designed to employ the logic of a geometric proof by deductive reasoning starting from self-evident truths (axioms in geometry). I was disappointed in myself that I had never realized it. I used that marvelous piece of trivia thereafter. The authors also show the great inconvenience of early cumbersome mathematical symbolism, which was advanced by Descartes in particular, but took much time to establish. Descartes discarded old baggage of strictly geometric reasoning that made it difficult to solve quadratic and other nonlinear equations. The authors also mentioned the story that Descartes got his insight for Cartesian geometry by watching a fly walk across a tiled ceiling. The book filled some gaps in my knowledge of math history. Greeks didn't talk of lengths but of ratios; 0 was a place holder at best. Descartes also did not have  $x$  and  $y$  coordinates – just an  $x$  coordinate with a distance off the  $x$ -axis. It made it seem that looking at math in the time of Descartes or before would be like reading Chaucer without a glossary and without the risqué aspects to hold your interest.

As you might expect, in the remedial geometry class there were many more 2's and 3's (and lower) than 7's or 8's. Days later when I subbed in a Pre-Calculus class that had students from 9<sup>th</sup> to 12<sup>th</sup> grade, a different but predictable pattern emerged. The 9<sup>th</sup> graders, the most precocious and

talented in math, gave much higher scores than the 12<sup>th</sup> graders, who were being dragged along. When I asked the class how they expected their ratings to vary by class year, they predicted perfectly and let me know it was obvious. One senior served as class spokesman. "The 12<sup>th</sup> graders are the math retards and the 9<sup>th</sup> graders are the math geniuses, so naturally they like it more than we do!" All agreed and he knew that all would agree without a moment's consultation with his peers. How's that for anecdote, you presumptive statisticians! And note how plainly the student talked – without regard to disingenuous PC euphemisms – and how none of the students felt in the least shocked or offended.

I mulled over the survey results. They helped inspire me to develop a sales pitch for math that I have presented in almost every math class except Calculus and I describe in Day #5.

#### Day #4: A Math Genius in Entitledale: Classroom Dynamics.

This was my first day at Hillsdale, on the more upscale side of town. I was happy to be the Sub in Calculus. I knew I would be ready for the students. However, as I walked in the room my heart sank a few notches. Here too, the seats were divided into two sections facing each other. You can advocate some merit for such an arrangement where debate is important. But in math, the derivative of  $x^n$  (with respect to  $x$ ) is  $nx^{n-1}$ . There is no debate! The teacher *IS*, or certainly should *BE*, the 'Sage on the Stage'. Students can profit by working in groups, but only after they have struggled enough to appreciate and understand the hint or 'trick' that had blocked them.

My heart plunged several huge notches more as the kids sauntered into the class loud and rowdy. Two of the classes had a terrible start. I could never get them quiet. In one class one pretty girl was the abuse ringleader, using her looks as a weapon. She made a peacock-like display of turning to her friends and talking incessantly. Others followed her example. It wasn't a riot – it was all done with just enough decorum to remain a sliver below chaos level, but it was still a rebellion.

I made a big mistake. I should have called the Dean as soon as I identified the situation, which was pretty soon, and rooted the rude young lady out. Unfortunately, calling the Dean didn't occur to me until the end of the day, when it was too late.

Fortunately, even the bad classes that day were not total fiascos. After all, how many Subs remember any math or had ever even taken, let alone remember, Calculus. I walked in, looked at the topics and assignments, and was ready to go in all classes.

The Calculus class was treating derivatives of the inverse trigonometric functions (e. g., the angle that has a given sine, cosine or tangent). I derived the equation for the derivative of the inverse sin, showing the pitfalls and tricks that are involved. In the first Calc class I mistakenly reversed variables at one point. Since not a single student caught my error, I pointed out that it was one that many of them would likely make on their tests so, "Watch out!"

In the second Calc class I made the same mistake of reversing variables but this time, did it deliberately. And again, no one caught it and again I pointed out that they would likely make the same mistake on their test. I also told them that in the first class I had made the error inadvertently but that in their class I did it deliberately because it was such a common error. I then preached that ego should never be allowed to prevail in math, science, or engineering. "If anyone makes a mistake – teacher, professor, engineer, CEO, anyone else can and must correct

them. Truth must reign supreme. Otherwise, the bridge you build will collapse or the patient you treat will die. Leave ego and bravado to the lawyers, priests, politicians and salespeople.”

The assignment for the Calculus classes included examples involving velocity. I quickly reviewed the formula for average velocity,

$$\text{Average Velocity} = \frac{\text{Total Distance Traversed}}{\text{Total Time Interval}}$$

Then I gave the classes the following problem. “Calculate the average speed of a train that travels 30 miles from point **A** to point **B** at 30 mph and immediately returns at 20 mph.”

Your immediate impression if you are not totally math illiterate is 25 mph. Of course, that impression is wrong. Consider the extreme case. What if the velocity on the return trip is 0? Then the train would never get back to point **A**. Since it would take an infinite time, the average velocity of 30 mph and 0 mph over equal distances is not 15 mph but 0 mph.

So, how do we solve the problem? The formula for average velocity requires dividing the total distance traversed by the total time interval. The total distance is  $2 \times 30$  miles = 60 miles. The time to get from **A** to **B** is 30 miles divided by 30 mph = 1 hour. To return takes 30 miles divided by 20 mph = 1.5 hours. Thus, the total time is 2.5 hours. The average speed equals the total distance divided by the total time interval or, 60 miles divided by 2.5 hours = **24** mph!

Almost all of the students got it wrong and couldn't solve it even after being told that 25 mph is wrong. Despite having the definition of and equation for average velocity, they couldn't set up the problem. There are several object lessons here.

1. Misleading intuition often distracts or lures us from basic principles.
2. The ability to stay disciplined and methodically use fundamental rules is rare.
3. The ability to derive even a basic formula is admirable and rare.
4. The ability to switch mental gears between two disciplines (e. g., physics and math) is admirable and rare.

Semester after semester as a Professor, I asked the students in my introductory classes two questions. First, if a car travels 60 mph for 2 hours how far will it go? Almost everyone could solve this. The answer is, distance = speed times time = 60 mph  $\times$  2 h = 120 miles.

But when I asked them to produce a general formula to find the time it would take a faster runner going say 10 mph to catch a slower runner

going say 8 mph if the slower runner had an initial lead of say 6 miles, this they found quite difficult.

The equation for time,  $t$ , in hours for a person going at speed  $v_1$  to catch someone going at speed  $v_2$  who has an initial lead of  $x$  miles is,

$$x = (v_1 - v_2)t \Rightarrow t = \frac{x}{(v_1 - v_2)}$$

Plugging in the numbers yields the solution

$$t = \frac{x}{(v_1 - v_2)} = \frac{6}{(10 - 8)} = \frac{6}{2} = 3$$

I allowed 5 minutes of class time for students to answer. Five silent minutes is an incredibly long time in a lecture hall, but isn't much time to derive a general result in math. In any case, many of the students gave up immediately, so they could have been given an infinite amount of time and would never have found the equation. On average about 1 out of every 30 students either set up the equation and found the answer or got close. Most classes in which I did this were for non-science majors but in some science classes the results were almost as bad.

Once I gave the answer almost all the students saw that the math wasn't hard but that the ability to construct even a simple general formula is quite admirable and surprisingly uncommon. I then rhapsodized... "The difficulty you experienced should make you admire scientists like Newton all the more because to develop and solve his physics equations he had to invent the right math (Calculus)."

The inability to derive simple formulas and see the inherent logic in problems forces many students to rely far too heavily on memory instead of intellect when they study. For example, on the blackboard I wrote,

$$a = b \times c \times d \quad \therefore \quad b = \frac{a}{c \times d} \quad \therefore \quad c = \frac{a}{b \times d} \quad \therefore \quad d = \frac{a}{b \times c} \quad \therefore \quad \frac{a}{b} = c \times d$$

I then asked how many fundamentally different equations I had written. I hope you can see that while there are five variants there is only one equation. It is easy to remember one and then derive the others using division or multiplication. The point is that longer equations have so many variations or combinations that memory will surely fail, but if you know the few mathematical operations, you need only remember one form of an equation and can solve for all the others.

Invariably, it was the poorer students who, despite all warnings, did not or could not see the pattern and attempted to learn by brute memory. So, as the number of combinations increased, their memories ultimately were overwhelmed and they felt inadequate and hopeless.

While I am on the subject, consider one of the great virtues of math. Proofs in geometry are deductive and perfect if you accept the assumptions (or postulates). By contrast, most arguments in law, politics, religion, and literature are inconclusive to some degree, but if the assumptions are clearly expressed some disagreement can be resolved. Perhaps then the deductive approach of geometry can help in the formation of arguments and solutions in other fields. Students need to be informed about this important characteristic of ‘irrelevant’ math.

*Back to the present.* Two of the classes were not too unruly and one class actually worked diligently and enthusiastically. I singled out a boy who in typical California style arrived on a skate board. He did everything he could to look unconventional. I offered him validation using a few key welcoming words and a little body language. After all, I am a klutz on a skateboard, so I admire his ability and talent.

I challenged him with a math problem the moment class began. He responded with an enthusiasm that caught me by surprise. He had no intention of acting rebellious. He was enjoying class and I got the distinct feeling that this was not normally the case with him. I’ll never know. His enthusiasm spread to the rest of the class. A single golden apple can light the barrel!

I reached a few others, but overall it was a tough, tough day. The richer kids of this school didn’t have a Dean of Death to contend with and besides, they were far more spoiled and, as a result, far more abusive than the poorer kids of San Mateo.

The sly viciousness of some privileged kids did not surprise me. Years earlier, when I was in the honors class of Far Rockaway High School, I had been astounded to see some of my most goody-goody, suck-up classmates metamorphose into the most abusive mongrels the moment a Sub appeared and no sword of Damocles hovered over their heads to nudge their grade point averages down a nanometer.

On this day I had witnessed two opposite examples of the enormous impact of classroom dynamics. In the first case, a single, bitchy cheerleader was able to tip a willing class toward chaos; in the second, an enthusiastic and somewhat goofy nonconformist, cut from the mold of the movie, *Bill and Ted's Excellent Adventure*, helped transform the entire class into a group of enthusiasts. When that happens, let it run. Giving great or enthusiastic students the run is one mark of a great teacher. And any teacher should consider it a blessing.

During the geological epoch my teaching career spanned I presided over a number of classes with magnificent classroom dynamics and several with abominable class dynamics. Let me recount one of the great ones. Late one summer, Richard H. found his way to my office. He had transferred from Georgia Tech, which he hated, and was looking for guidance. It took about 1 microsecond for me to see that Richard was real bright and *real* interested in learning. Instead of the almost universal, "What are the career opportunities?" question that I always answered with "[What do you love?](#)" Richard wanted to know if he could design an academic program of courses that would match his love. I told him that our department would back him to the hilt in creating an interdepartmental program that would fit his wishes to a tee.

Richard turned out to be my Franz Schubert. Schubert learned music so fast that his famous teacher, Antonio Salieri (inappropriately denigrated in the movie, *Amadeus*) is quoted as saying, "He must be taught by God himself". When I taught computer programming Richard was improvising while the other students were saying, "huh", and "duh". Richard later went on to be a principal programmer for a successful Mars landing.

By sheer fortune, when Richard took my course, *Introduction to the Atmosphere*, he was joined by two other weather nuts, Bob B. and Andrew N. Bob was a real quiet nerdy guy in his late 30's who looked like he was in his late 50's, had probably looked like that for at least 30 years and probably would continue to look the same for the next 40 years. Andrew was flaky and undisciplined – another enthusiast out of the mold of *Bill and Ted's Excellent Adventure*. Together this trio formed something of a Three Musketeers, who roused the class. There wasn't anything I could do wrong in that course. A number of the students kept contact with me for a few years and several of the women in the class thought I was the greatest Professor or teacher they had ever had. That doesn't happen every day, certainly not to me.

Then there was my class from Hell. Let me offset that fiasco with some preliminary self-praise. I think I was, for the most part, a great lecture teacher, and the larger the class the more dramatic I got. My ratings from students before Open Admissions eviscerated City College for over a decade were consistently high, and, as a visiting professor at UCLA in 1985-86, I got the highest ratings by far in the history of UCLA's Atmospheric Science Department. That was the Good.

[Note: My UCLA students averaged 68% on the same tests my CCNY Open Admissions students averaged 48%. Since the course at UCLA had a one hour lab each week, I didn't post for them the sample questions *and answers* that I posted at CCNY a week before each test.]

Now for the Bad and the Ugly wrapped into one. In fall, 2009 I took over the large lecture class on Global Climate Change for non-science majors. Just about everything possible that could go wrong did go wrong with this class. For starters, the auditorium was typically locked and I was refused a key so almost every day, I had to draft some busy people in either of two busy offices to open the room. Despite arriving at least 15 minutes early, there were days I had to keep the students waiting to enter the auditorium.

The auditorium's audiovisual facilities were horrendous; it was certainly not designed to be a lecture hall. The sound volume was always set so high that amplifier feedback caused a deafening screech whenever I stepped near the front of the stage, and even when I retreated to the back of the stage I was restricted to clipped 3 or 4 word phrases that had to be punctuated with several seconds of silence. The audiovisual staff refused me the keys to the boxes that controlled the loudspeaker volume and stage lights and refused to correct the situation except on the few days when some public relations event followed my class. The last 3 weeks of the semester the colored stage lights remained locked in the on position. Pictures of forests and glaciers looked strangely red.

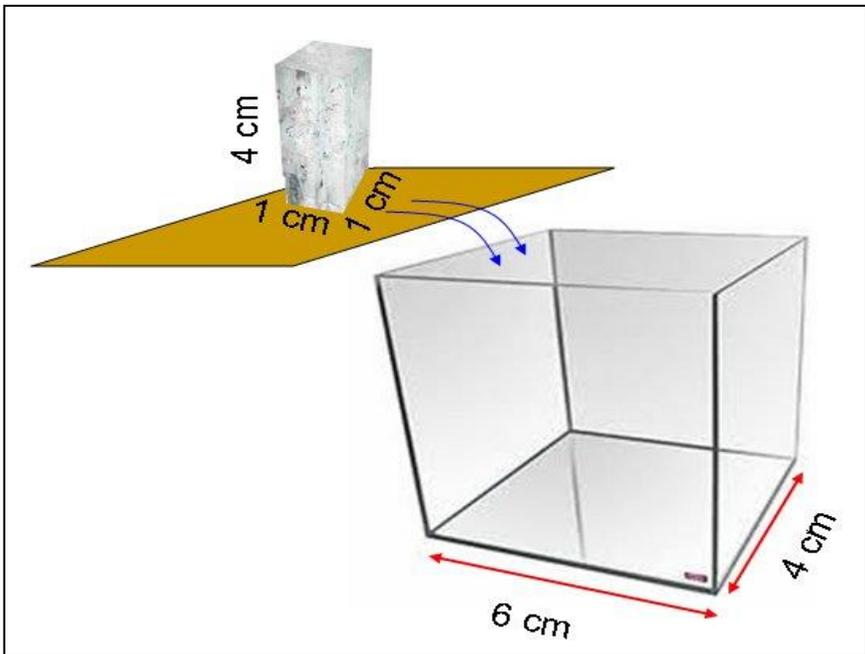
While the colored stage lights gave new hues to the PowerPoint Presentations, the projector made them vibrate violently because it was mounted on a long arm from the ceiling behind a glass window in the locked audiovisual room at the back of the auditorium. Continuous earthquake amplitude waves from pounding pumps in the basement shook all images or writing displayed on the large screen so vigorously it made everyone dizzy. This problem had plagued other classes in that auditorium. I finally got someone to open the projector room. I then damped the oscillations by wedging a large chunk of Styrofoam between the projector mount and the window. This reduced the amplitude of vibrations by 90%, demoting the problem to a mere nuisance. Given the audiovisual conditions, the students had every right to be disgruntled.

[One year later the course was given in a different, standard lecture hall with functioning audiovisual equipment. I gave two guest lectures and got a rousing response from the students.]

The next problem began as a lack of communication and ended with out and out conflict with my Department Chair, who had taught the course the previous year. In an attempt to make the course consistent with what he had taught I asked him for his curriculum, lecture notes and lab exercises. He was never able to find anything – he had deleted it all from his web site and it had vanished into the æther. He did tell me that since his roughly 280 students had performed so poorly on his easy tests he simply discarded the tests and gave them a term paper instead. He

claims he read all 280 papers and that most students wrote excellent papers. I think not on both accounts. So I had no idea of what he did with or in the class but I do know one thing that he did to the class – he gave such high grades with such little work, the course acquired a reputation as an easy, do nothing A.

With no guidance, I wrote the course curriculum, the PowerPoint Presentations and the Lab exercises. Unfortunately, due to loopholes in our department's academic program, two of the three lab instructors had never taken a course in either Climatology or Meteorology. Furthermore, their schedules were so filled including responsibilities at other campuses that there was no common time to discuss the labs. I had to meet with each instructor individually.



**Fig. 3. Calculate water depth in a container when ice melts.**

I went to a number of labs the first few weeks to assist. They were marked by a profound degree of student passivity. Most students simply didn't know and didn't want to know what to do. As an example, one serious and possibly grave consequence of global warming is that sea level will rise. The relevant lab involved estimating how much sea level would rise if the Greenland and Antarctica ice sheets melted and ran into the oceans. First, though, the students were asked to solve the simpler

problem illustrated in Figure 3, namely to calculate how much the water level will rise in a wide tank when a tall, narrow block of ice melts and pours into the tank. They were told that to solve this they must first calculate the volume of the melting ice and that the area of the tank is important. They were encouraged to ask any question that might help.

The principle is that the volume of melt water,  $V_w$  is approximately equal to the volume of the original ice,  $V_I$ .

$$V_w \approx V_I$$

In fact, water is slightly denser and hence more compact than ice so its volume is roughly  $\frac{8}{9}$  that of the ice. Not one student raised that subtle point and we didn't trouble them with it.

Next, volume of a block or tank equals length  $\times$  width  $\times$  height.

$$L_w \times W_w \times H_w \approx L_I \times W_I \times H_I$$

Substituting the known values leaves only one unknown,  $H_w$ , the height of water in the tank.

$$4 \times 6 \times H_w \approx 1 \times 1 \times 4$$

The final step is to solve for  $H_w$ ,

$$H_w \approx \frac{4}{24} = \frac{1}{6} \text{ cm}$$

Thus, when a tall (4 cm) but narrow column of ice melts and pours into a wide tank, the water level will rise by a much smaller height (1/6 cm). The idea is the same as one we encounter frequently in everyday life – a tall but narrow glass may hold less soda or beer than a short but wide glass – and merchants know this selling point quite well.

The hope was to follow this 'simple' example by tackling the problem of global sea level rise that would result from the melting of the world's ice sheets. But it was hopeless. Each of the steps above was like pulling teeth without Novocain – sheer agony. So, the class never got to even start the problem of sea level rise because the preliminary problem took the brightest or most vocal members of the class the entire hour to do, perhaps because it involved the abstruse mathematical processes of multiplying and dividing. The majority of the students couldn't formulate or understand the problem and, in a state of profound mental passivity, frantically copied it from any neighbor who could.

It has become a national custom for students to capitulate the moment they experience the slightest difficulty and head to tutors. Our department had no funds for tutors so the lab instructors and I kept our

office doors open as much as possible. Right before tests I did get a small number of visitors. Otherwise my office was empty.

A week before Test #1, I gave a list of 25 sample test questions, all essays or problems. I announced that 9 of the 10 test questions would be taken from the list with no modification other than changing numbers in problems involving formulas. Only one of the questions on the test was not solved verbatim in the Labs or PowerPoint Presentations, which were on the Website.

The class average was 40.4%. That was the second lowest average on any test over all my years of teaching Introductory Science for non-science majors. Only a 37% by the worst class at the depth of Open Admissions was lower. I had thought that with the termination of Open Admissions in 1999 the non-science students at CCNY had improved. Was I wrong! My colleagues sadly agreed.

Complaints from students began cascading to the Chairman even before the grades were handed back – it takes a great deal of time to grade 260 short essay and problem solving tests. The Chairman backed the complainers without checking with me, his colleague of 40 years. That gave more students a green light to complain to him and to rebel in class. Under pressure I folded and violated my professional integrity. I prostituted myself by

1. Giving the exact same test again as a retest.
2. Making it an open note test.
3. Giving it as a take home test.
4. Allowing the students to work together.
5. Giving 7 days to do it.

Give up your principles once and you will regret it always. The average on the retest rose to 63.0%, a pathetic performance considering the conditions. Where in the world was their work ethic? I was aghast by the incompetence and indifference of the bulk of the students. Even though the deadline was the beginning of the period on the 7<sup>th</sup> day, I saw several dozen students in the anteroom of the lecture hall begging answers from their fellow students and coming to class late on deadline day. I folded again, accepting late papers. Open rebellion was in the air, implicitly backed by my Chairman.

Now for another faux pas! On the first day, I had announced that each student had to purchase a scientific calculator (no smart phone with internet and storage was acceptable) and this requirement was included in the course package. Perhaps  $\frac{1}{3}$  of the students had purchased this \$10 or \$15 item by the time of the first test and they were passing the

calculators around during the test along with other suspect activities difficult to detect in the auditorium.

Without a calculator you can't solve number problems if you lack number skills, as many of today's students do. As the second test approached I warned them that there would be no borrowing calculators, as there had been on the first test.

That is when I committed the faux pas. I said, "[Consider a calculator to be a condom that will protect you from failing a math problem so be sure to buy one and use it.](#)" The use of the word, condom caused self-righteous outrage among a number of students. Because I used the word outside the auspices of a health science class, I was accused of sex abuse (surreptitiously, of course) so that, as I was informed afterwards, several of my lectures were observed by some investigator sent by the Dean. Fortunately the charges came to nothing. You want to screw someone up real bad in this insane society of ours – accuse them of sex abuse. You won't need any evidence and you won't suffer any consequences.

Two weeks later, I committed a once in a career coup de grace. An emotionally disturbed student disrupted the lecture when he couldn't get the animations in the PowerPoint Presentations to work on his Apple Computer. (I programmed the animations in Visual Basic on a PC.) He began yelling that I was responsible for making everything work for everyone on any computer platform, and he wouldn't stop. This outburst was not his first, but was his worst. I should have had him quietly removed by Security. But with all the student criticisms supported by my Chairman in mind, I lost it. I not only confronted the student but proceeded to ask everyone else in the entire lecture hall to air any of their grievances.

The cardinal rule in class dynamics is that the teacher must appear or better yet, be on the side of the students. Never alienate them and make yourself their enemy. In 40 years of teaching I had zealously observed that law, both in the letter and the spirit, because I really have always sympathized with students who want to learn, but this time I screwed up royally. It turned out that the student, who was African American, with all the potent complications that adds to the mix, had been disowned and banished from his family when they discovered he was gay, and he had made a custom of venting against any authority figure he could bait.

Before the next semester began, my Chairman did have a useful hint. "Stan, since you are such a tough grader, warn the students in advance." On the first day of the next semester I barked at my new, blameless students, confessing how I had prostituted myself by violating my eternal principles the previous semester, and would never do so again. I told them of my reputation as a tough grader and that many students

considered my tests impossible. I warned them that in place of attendance I gave pop quizzes and if they missed 5 I would drop them. (Later I found out that I can't do this even though missing more than 4 lectures or 2 weeks used to be automatic failure.) Then I practically screamed at them to drop the course while they had the chance and take a gut course in its place. Surprisingly, everyone sat there and no one dropped (until after the few, usual suspects dismally failed the first test). The students submitted to my outburst and some actually came to enjoy the course. I was back on track. You can't keep a good teacher down.

Yes, a great teacher can improve classroom dynamics. In a single hour a Master Sub may not be able to move the Earth but he or she can start to give the students a platform to stand on.

About a year after my debacle I saw *The King's Speech*. I was blown away. The future King George VI, played by Academy Award Winner, Colin Firth, goes in secrecy to Lionel Logue, played by Jeffrey Rush, a self-taught and self-trained Speech Therapist. This maverick master had to ameliorate the Prince's terrible stuttering problem while dealing with the Prince's unalloyed arrogance and scorn, filled with tantrums and scathing, humiliating insults. Despite the relentless onslaught (surely exaggerated for dramatic effect), Logue remained steadfastly professional at every moment. His sole focus was his dedication to the welfare and ultimate triumph of his student. He proceeded with full faith in himself, knowing that he was doing the right thing, and he could not be swayed nor compromise his principles.

I wish that in that dismal Climate course I had been more like the Lionel Logue of the film. For most of my career I was more like him. But it was an unforgivable lapse. I hope I learned both from the film and from my failure that semester.

## Days #5-6: Selling Math. Innovators and Bonding

I was the Math Sub in Aragon for two consecutive days for two different teachers. Some distinct memories emerge from the blur of the 10 math classes, all with different students.

Back on Day #3, when I saw how strongly the majority of students in the remedial math class disliked math, I presented, in protean form, a sales pitch for math. The core of the pitch is that while it may well be that no one can change a student's feelings about math, the student who dislikes math will probably be one of the Economy's losers. Every day after that I improved the presentation, giving it after collecting the survey in every math class except for Calculus, where I felt it was not needed and where they needed all the time to solve problems. I've got that pitch pretty polished now, so here it is its current form.

"You may or may not like Math but I am going to sell it because it is extremely important to you whether or not you ever do another equation once you leave your last math class. If you don't know Math, others who do know Math will take advantage of you.

The financial collapse of 2008-09 we are just beginning to emerge from was caused not only by greedy, swindling mortgage brokers, bankers and politicians, but by a nation filled with math morons. Sure, the rich boys were out to sell the suckers a bill of goods. Millions of people bought mortgages they could not afford and went down with them hook, line, and sinker. After 12 years of math in school, where they start teaching percentages before 6<sup>th</sup> grade, millions of people couldn't figure out how much the interest on their mortgages would cost.

One of the main roots of the problem began back in 1999. Does anyone know who was President then? Mostly silence, huh! Well, you were too young and after all it is ancient history. But just in case you are interested it was Bill Clinton, a Democrat. Clinton, and his banker-advisor cronies, along with an eager Congress repealed the Glass-Steagall Act of 1933. That act had prohibited the Banks from passing off their risk by selling the mortgages they created.

As soon as Glass-Steagall was repealed, the Bankers and Mortgage Brokers began to court millions of investors, essentially saying to them, "We are going to give you a \$500,000 mortgage for a house that isn't worth \$300,000, even though we know you can't afford \$100,000 because using what mathematicians call a random number generator we are going to splice your mortgage and millions more into worthless pieces of paper with the fancy name, Collateralized Mortgage Obligations (CMO's) and then sell the CMO's for \$600,000 apiece. After a few months we will splice the CMO's further so that even God could

not decipher and reassemble the fragments. These disguised pieces of trash we will resell for \$750,000. Thus will WE, the bankers, pawn off our risk onto YOU, the hapless, unsuspecting, and yes, greedy speculators all around the world!"

Eventually, someone pulled down the Ponzi scheme's pants and revealed that the Emperor had no underclothes. Community panic followed in the tracks of community greed. The bubble burst, the house of cards collapsed, i.e., the Real Estate Market was dragged down and, to my surprised dismay, took the Stock Market, where I have my savings, with it. Tens of millions of people found themselves in deep debt, jobless, foreclosed, evicted, and homeless. The Construction Industry, which had been white hot just a few years earlier, approached extinction.

And, as for the suckers who bought the mortgages they couldn't afford, they didn't even know the simple Math they had spent 12 years in school trying to avoid.

Math is a language. It is a difficult language because it is abstract and because we do not speak it. But it really has a very small vocabulary. Here is your math dictionary (in Table 1). With this vocabulary you can do almost all word problems.

<b>Word</b>	<b>Symbol</b>	<b>Meaning</b>
<b>What</b>	x	the unknown
<b>Is</b>	=	equals
<b>Per</b>	/	divided by
<b>Cent</b>	100	one hundred
<b>of</b>	×	times or multiplied by

**Table 1. Dictionary of math words, symbols, and their meanings.**

Now let's do a word problem. What annual income do you need to afford a \$500,000 house, the cheapest house you can get here in San Mateo? Start with the interest payment. A typical interest rate is 5% although rates are somewhat lower now if you can get a mortgage.

So, question is, "**What is 5% of \$500,000?**" Let's turn that into an equation using our math dictionary. We say, the unknown interest,  $x$  (=) 5 per (/) cent (100) of (×) \$500,000. The equation is then,

$$x = \frac{5}{100} \times \$500,000 = \$25,000$$

That's a great start and we've done the major part of the problem. But interest is only one expense in any family. You also have to pay

1. The principal on the mortgage,
2. Federal, State, Sales, and Real Estate taxes,
3. Transportation,
4. Food,
5. Utilities,
6. Education,
7. Entertainment,
8. Health,
9. Insurance and,
10. (-1000) Everything else.

With all these other expenses, a good formula is that your income must be at least 4 times larger than the interest payment. So, if your house costs \$500,000 you need an income of at least  $\$25,000 \times 4 = \$100,000$ .

But here in San Mateo, we live in a bubble caused by all the math nerds of Silicon Valley with their extremely high incomes. The cheapest, dumpy houses here are \$500,000. Between El Camino Real and Avenida de las Pulgas houses are typically near \$1,000,000. So they need incomes of almost \$200,000. And west of Avenida de las Pulgas house prices are much higher - typically \$1,500,000 at first and then 2 to 5 million or more as you climb the hill. So the people at the top of the hill need incomes approaching \$1,000,000. If you don't believe me about the house prices, look up the estimated values in Zillow.com. Then you can find the value of your friend's and enemy's houses. You can be as obnoxious as you want. But the main point is that the prohibitively expensive peninsula you are living in proves that math nerds rule the world."

\*\*\*Alert!! When I repeated this presentation in August 2013, I was astounded to see how much the same house prices in San Mateo rose in only 4 months. The estimates had ballooned from a range of \$800,000 to \$900,000 in April to a range of \$1,400,000 to \$1,500,000 by August, and by the spring of 2014 they reached \$2,000,000. Apparently, Facebook millionaires diving into the Peninsula's tiny available housing pool accompanied by wealthy investors from China and India were responsible for raising that tide so dramatically.\*\*\*

During this presentation involving money, thievery, and stupidity, the kids are almost always silent and attentive. But the moment the drama is

over, some kids, especially those who are poor at math, become restless as quickly as instant coffee.

To avoid turning the hour into Shock and Bore, I followed my sales pitch with a very short lecture on the subject of the day and quickly distributed the exercise.

Why do I as a Sub lecture at all when a Sub's silence is supposed to be golden? First, every teacher presents material in a somewhat different manner. This gives students the chance to get a second viewpoint. For those who have not caught on, a slightly different treatment presented in a slightly different context and from a slightly different angle may just be the match that finally lights the candle.

On the second day, some of the students began to recognize me in the large open quadrangle during a break between classes. This gave me a warm feeling. The glow lasted until shortly after the next class began. It was an AP Statistics class. One of the girls turned 180° in her seat and began talking conspicuously while I was lecturing. (I have since observed that girls do the 180° more than boys. Boys tend to be louder.)

Without breaking stride, I said, "[Statistics has strong and weak points. Although you'll never know who'll turn around 180° and disrupt the class by talking rudely when the Sub is teaching, statistics enables you to predict the average number of students who will do that.](#)" She promptly turned around and faced forward, perhaps because she was Asian-American and a good student. That little sermon wouldn't have worked with a poor student, but then again it was an AP class.

The next period, filled with repeaters, was Algebra 1. At the beginning of the period a student aide announced herself to me. Many of the tough classes have student aides, the bulk of whom either sit anonymously in the back of the room doing nothing or come up and ask for a pass to the Library, saying that's what the teacher usually does. But this young lady was different. She was a star. She clearly loved math, was great at it, and was proactive. What a pleasure! What a treasure! She helped the troubled students solve their problems throughout the period. Whoever says, "It's not what you know, it's who you know" has a flimsy hold on a tiny corner of the truth except in monarchies and tyrannies.

Imagine a 10 pound weight on the floor that must be lifted onto a table. Each of the first 9,999 people tries to lift that weight using 9.9 pounds of force. It never budes. Then the 10,000<sup>th</sup> person uses 10.1 pounds of force and lifts the weight on the table. In this world, only a fraction of the people put in the needed effort to get the job done. Once you find them never let them go, even if they are obnoxious, which this pleasant, charming young lady was definitely not. She was worth more than all the inert student aides lumped together.

But even with this young lady's help there was a group of persistently rowdy boys who exceeded my patience. So, I finally called the Dean. Perhaps only three minutes before the class ended they were gone. Having broken the ice Dean-wise, I would not wait so long again.

One interesting interaction occurred during lunch. During Day 0's training session we were advised to show our face to the faculty. Therefore, I decided to show up in the Faculty Resource Room and join whoever was there for lunch. Now, I have been in many new situations. I went on three sabbaticals at different Universities, where I had to get to know new sets of faculty and students. I joined summer programs, and attended huge, ponderous scientific and educational conferences. So more than a few times I have been the new kid on the block, or one of the new kids on the block. People need time to bond. So, don't push too hard. Give people time. Eventually some of them come around.

Most of the group at the lunch table nodded when I introduced myself and then acted as if I weren't there. However, one teacher put on an ostentatious show of snubbing rejection. I was sitting on the south side of the table. He was sitting on the east side. His whole body rotated as a solid rod about  $120^\circ$  away from me, toward the northwest. He focused razor sharp attention on a colleague sitting across from him and began making a grand show of bonding. Hadn't he encountered his colleague of a decade in the Faculty Resource Room countless times before that day? Oh, how he rhapsodized on their days in the same high school years earlier, talking as if he hadn't seen the guy since the Senior Prom.

The scenario reminded me of the joke about two men in a pub who greet each other effusively and discover with great amazement that they come from the same town, went to the same high school and were in the same graduating class. After they leave the bar arm-in-arm, an outsider who watched this reunion with amazement asked the bartender about the touching display and the bartender said, "Oh, the O'Hara twins always do that."

This teacher's body language was telling me that I would not enter his "Club". Perhaps he had experienced trouble entering the Club himself. He was African American in an almost exclusively White, Asian, and Mexican town. I decided not to tell him that I knew exactly what he was doing and where he was coming from. I did the right thing. If I had pointed out the truth I might have gotten some secret acknowledgment from others but would have gravely insulted the insulter without him learning anything. Bonding takes time. I was cool because I've been there before. We all have. Especially we Subs! Just try walking into the Teachers' Resource Room with a Sub ID!

## Day #7: Boundaries and Behavior: Games and Brain Teasers

Back at Hillsdale High! I subbed for a Social Science Teacher who had laid out ground rules to her students for treating Subs with respect, and lo and behold, her classes were well-behaved. Judging from rowdy or abusive student behavior on so many other days, I guess that very few teachers and administrators follow her admirable example. Having been assailed in so many classes of the previous days, I felt as if the students had declared a truce. In between classes I was also recognized once again. That eye patch was really helping.

My reading also helped. Unfortunately, my memory or power of immediate recall of all I have read is limited. This means that I should develop a repertoire of relevant books but lacking (or in addition to) that, continuing to read often gives me fresh material. This was the case today.

After attendance, the first period began with a test. The class finished early. In the remaining time the assignment was to complete an exercise. I had just read Jonathan Haidt's *The Righteous Mind: Why Good People are Divided by Politics*, and chose to describe it briefly before handing out the exercise. [The briefest summary is that Conservatives tend to prioritize individual responsibility and Liberals tend to prioritize Empathy.] I then summarized a Cooperation-Competition game that contained a political and sociological lesson.

In the game, students in a class went to computer terminals and were placed in anonymous, groups of 4. The rules of the game are as follows. There are 12 anonymous rounds. At each round the people are reshuffled randomly, so the groups are constantly changing and always anonymous. At the beginning of Round #1 each person starts with 20 chips. In each round participants put as few or as many as they want into the common group pot. The chips in the pot are counted, increased by 60%, divided into four equal portions and redistributed to each group member regardless of what each had contributed. As an example, imagine that 3 of the 4 members put in 20 chips apiece and the 4<sup>th</sup> member put in 0. The 60 chip pot would be increased by 60% or by 36 chips to 96 chips and each member would get 24.

You might imagine that the 3 people who each contributed 20 chips and wound up with 24 would feel stiffed, while the fourth member, who now had a total of 44 chips would smirk at his companions' gullibility. Remember that after each round, groups are shuffled randomly so you no longer deal with the same people and all remain anonymous. Even so, your feelings are affected by the behavior of group members in previous rounds.

The average contribution on the first round was 10 chips. By the end of the game, 12 rounds later, the average contribution had decreased to 4 chips.

Then the game was played again but with one additional rule. You still didn't know who was in your group but this time you could punish any cheapskate 3 chips by paying 3 chips yourself to do it. Once again, the average contribution on the first round was 10 chips, but this time the average contribution on the 12<sup>th</sup> round rose to about 15 chips.

Conclusion: Generosity increases when people have the right and power to punish those freeloaders who don't contribute or cooperate and decreases when our actions have no bounds or consequences – when there is no right or power to punish or discipline. Give one point to Political Conservatives.

Don Starkell reached a similar conclusion in his account, *Paddle to the Amazon* about the 12,181 mile canoe trip he took with his son (from Winnipeg, Canada, down the Mississippi, around the Gulf of Mexico and the Caribbean, up the Orinoco and down the Negro and Amazon). In countries where the rule of law was strong, he found people to be incredibly helpful and friendly. Where either chaos or tyranny reigned, people were nasty, abusive and brutish.

After listening to my short sermon, the students went to work on their exercise and finished it ahead of time. If this had been a college class I could have dismissed them early, but you can't do that in high school. A few of the kids were demonstrably bored. So, I gave them some brain teasers. They really went to town on them. Here is one teaser.

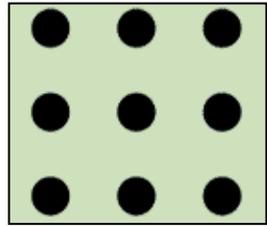
There are 3 Cannibals and 3 Missionaries. They all want to cross a crocodile infested river and can only do so in a single row boat that holds a maximum of 2 people at any one time. If they cross the river in such a way that the Cannibals outnumber the Missionaries at any time on either side then the Cannibals will eat the Missionaries. How can you get them all safely across? It is a logical problem that takes a bit of thinking to solve. I'll start you off. Follow me with either checkers of two different colors or two different types of coins. If you send 2 Missionaries on the first trip then one Missionary is left among 3 Cannibals and will be eaten. Game over! So you must start with a different combination. No tricks, just reasoning and experimentation – Go! [The steps in the solution are listed on p. 67 and the difficult step is written in boldface.]

Not everyone wants to do these brain teasers and I make no attempt to coerce or compel them to do so. The students exhibit a wide range of responses. Some don't even give it a moment's thought. Others come to immediate conclusions and don't recognize that it requires thought and

experiment. Some abstain and defer to recognized class 'geniuses'. Others really go to town.

In all the classes I have subbed in and given brain teasers, a select number of problem-solving students show great interest and enthusiasm. They work in ill formed groups – working solo at times and together at times. They question, teach, test and challenge each other. It is the best form of cooperative group action and learning I have witnessed. It is the ideal of cooperative learning. They never need any instructions about how to work in groups. Yet, in all my years of teaching experience, I have never seen such enthusiasm with an 'official' team run classroom or lab assignment. That may be because the brain teasers are 1: voluntary and, 2: only involve the motivated students.

In the second class, Economics, I showed the movie, *Tommy Boy*. What a joke! But it made the time easy and I love the movie anyway. Since it was a double period, the film ended before the bell rang, so I gave a brain teaser that interested the whole class this time. Cover every dot in the grid of 3×3 dots shown in Figure 4 using only 4 linked lines. (Figure 5, on the next page shows the solution.) Everyone was intrigued, sure that there was some trick. One student finally got it. Wow! Was he proud, and I duly praised him for "thinking outside the box."



**Fig. 4. Dots for the 4-line Game.**

The last and easiest class on this easy day was gym. After a mix-up because there are two gymnasias, I took the class out to the track where their assignment was to run or walk. You can guess what they did. I challenged one guy to walk around in less than 3 minutes and he sort of tried but stopped twice to talk. It was all cool; I did not have to keep them quiet. They could scream all they wanted, and the result was the easiest class I ever subbed in. When the period was over the kids simply wandered into the sunset, as did I.

### Solution to the River Crossing Problem

1. Two Cannibals cross
2. One returns
3. Two Cannibals cross
4. One returns
5. Two Missionaries cross
- 6. One Cannibal and one Missionary return**
7. Last two Missionaries cross
8. One Cannibal returns
9. Two Cannibals cross
10. One returns
11. Last two Cannibals cross

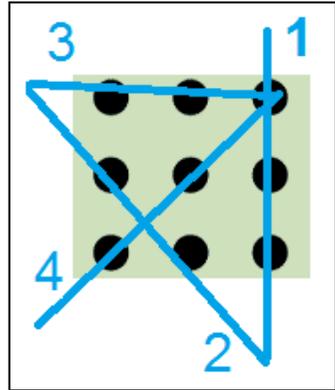


Fig. 5. Solution of the 4-line Game.

## **Day #8: Earth & Integrated Science: Prejudice and Pseudo-Integration**

Today, it's off to Earth Science. Hooray! Here I have not only knowledge, I have credentials. The assignment concerned the density of materials. Density is an important quantity because materials denser than their fluid surroundings sink while materials less dense than their fluid surroundings rise. The Earth's core is largely iron because the dense iron sank to the center.

The first period was free, so I explored the room and found enough material and equipment to construct a demonstration of how to calculate the density of irregularly shaped objects such as rocks and minerals. Density is mass divided by volume. Mass is easy to measure. Simply use a scale. But there is a trick to finding the volume of an irregularly shaped object, which only works if it is impervious. Immerse it in water in a graduated cylinder with volume lines and measure how much the water level rises.

Best laid plans of Mice and Men. The demonstration was a dud because their teacher had already done it.

Whenever students get material they've already seen and grasped, they lay claim to it. That gives free rein to a natural human arrogance and deepens the conviction that the Sub is not knowledgeable or worse, unqualified. It is very difficult to recover from such an inauspicious start. It is like the situation where a lawyer asks a question he or she does not know the answer to and is surprised and made to look foolish and worse, incompetent.

For the rest of that period I tried too hard to undo my quickly acquired lowly reputation. I told them about Archimedes and showed them that the way to determine the interior structure of the Earth is based on knowledge of its density from Newton's Law of Gravitation and from the speed of earthquake waves that travel through the Earth, its Mantle and Core. When one boy snapped a towel at another as if they were in the locker room, I didn't come down on them but asked if anyone knew the speed needed to crack a whip. One kid knew it was the speed of sound in the material. I was impressed and he was proud he had impressed me with his knowledge. I survived the class but certainly was not knighted. There are better ways to handle such setbacks.

The last class of the day was 'Integrated' Science. Integrated Science! That transparently obvious euphemism raised a major red flag even though my job was ostensibly real easy – show a film on the chemistry of volcanoes and have the students answer some simple questions. The teacher's note had raised a preliminary warning flag. It read, "Watch out

for a group of jokers in that last class. It will be a tough class – give no leeway!" As they began to file in, one short, evil looking boy glanced in the room and seeing me, a Sub, let his comrades know that he was leaving for some greener pasture. I breathed a sigh of relief. I was premature. His comrades did not follow him. Instead, they marched into the class. One offered me a high-five. I would sometimes accept such a 'friendly' offer but this time, no way. I wasn't going to offer myself up as a sacrificial lamb.

The raucous joking and chaos began with the film. "[You have one warning and then I will call the dean.](#)" That dire threat did neither me nor the rest of the class one iota of good. So I called the dean. I admit I wasn't too courteous to him. I abruptly commanded him to come over and remove them. "I need names" he said. "[I can't give you names. They won't own up to anything and they're not in their correct seats.](#)" After a few repetitions of the same lines the Dean did a turnabout and suddenly became proactive. "I might know them." Might know them? He would have bet his wife's life, his kids' lives and maybe even his own life that he knew them – and he proceeded to name every one of the little darlings. The other students began to give names at almost the same time, but the Dean beat them to the punch. "Are they Rodriguez, Santiago, Sanchez, Ruiz, Ortiz, Mendoza, Cardenas?" He rattled off what sounded like a Hispanic telephone book. One of the *Magnificent Seven* denied being bad because he had begun to quiet down just as I was dialing the Dean. So on leaving, he hissed to me, "F\_ \_ \_ you"! I told him that he had just confirmed my assessment, and off he went.

The remaining students were actually happy when the disruptive boys were expelled. They were finally freed, just like the 'Winkies' were when Dorothy melted the Wicked Witch of the West, though as you might well expect, none said anything while they were in class. Everyone settled down and watched the rest of the video in peace and quiet. And so, the day ended like a serene sunset. I was on my way to winter in Florida.

### **Personal Baggage**

Before you get too comfortable, that class roused touchy issues in my mind. Touchy, that is, but not feely! They are the issues of Integration, Race, and Prejudice.

Back in 1954, before I was 10 and long before I had any awareness of the News, Brown vs. Board of Education set Integration in the Schools as a National Mandate. Ah, yes, but as Tip O'Neill said, "all politics is local." So, in the 60+ years since that decision, one state and one locality after another has placed one roadblock after another, as Jonathan Kozol (*Savage Inequalities: Children in America's Schools*) among many

others have pointed out. I have already detailed how I as a parent consciously joined the roadblock party. I wanted my kids in the best schools, so that while we lived in an upscale condominium embedded in a working class town, we sent our kids to Private School. When their Private School days were about to end, we moved to an upscale town with an upscale school system that was de facto exempt from integration. It was, as they say, Lily White and I add, Asian Plum Rain.

My parents and my schools practiced the same segregation policies, almost by default. PS 104, in Bayswater, Queens was 90% Jewish and almost 0% Black + Hispanic + Asian. Only in 6<sup>th</sup> Grade was there a Black boy in my class. Anthony, a lost, shy boy, came in the middle of the year and lasted only a few weeks even though we kids all treated him kindly and gently.

But in Junior High School there were loads of Black kids and a finite number of Puerto Ricans. They either lived in Hammels or in the Redfern 'Projects'. So, JHS 198 was integrated but the classes in JHS 198 were not. I was in 7 SP 3. There were 3 SP (i. e., Special Progress) classes. About 100 of us did 7<sup>th</sup>, 8<sup>th</sup> and 9<sup>th</sup> grades in 2 years. As with my Grade School, about 90% of the SP students were Jewish. There was not a single Black or Hispanic kid in SP. I remember being stunned by it. Even then I knew something about the impact of environment but thought that such exceeding disparity couldn't possibly be due entirely to environment. After all, everyone took the same tests, and we (or at least everyone in my class) had not been prepped for the tests at all. I don't remember my grade school teachers being too good either.

In any case, there were a few integrated classes. Gym was one. Music was another. There, we were paired with 7-21, the dumbest 7<sup>th</sup> grade class. We all sat in the front of the Auditorium. My class sat in the left section and 7-21 sat across the aisle on the left side of the center section. That narrow aisle was wider than the Grand Canyon. We virtually never mixed. Those kids (almost entirely Black and Puerto Rican) were real rowdy, but we were no angels either since Music didn't count in the GPA. There was a sneaky discipline in our misbehavior. But the 7-21 kids acted differently. They were much tougher and much more direct in their misbehavior.

JHS 198 was pseudo integrated. So was Far Rockaway High School. The Selected Students Program did not have a single Black or Puerto Rican. By contrast, City College was open to all provided that you met the stringent admissions standards. There was only a thimbleful of Blacks when and before I went there as a student. Colin Powell was one of those few. He had graduated from my Department as a Geology Major in 1958, seven years before I did.

This brief outline shows that I grew up with pseudo-integration. Many of us in America have experienced pseudo-integration. My wife, Bernice, grew up in Statesboro, Georgia. There she experienced outright Segregation. *Driving Miss Daisy* and far uglier or sorrier scenarios, such as portrayed in *The Help* were no strangers to her.

Race was and remains a hot button issue in America. At the age of 7, I discovered the Far Rockaway High School Pool. On summer days that I did not go the Beach, I went to the pool, just across the street. I loved that pool even though I did not learn to swim until I was 9. I just played in the shallow water until I could swim. Forty kids were allowed in each hour for an hour and you were technically not allowed a second consecutive hour. If you came in the middle of the hour you had to wait outside. I then often watched the Life Guards on break playing handball. They sometimes asked me to run to the nearby store and buy them a Coke. I was glad to help the grown men. But I didn't like it when I heard them talk venomously about the 'Niggers'. I had mistakenly thought that as grown men they would have outgrown any small mindedness.

However, I had my own issues. Many of the kids were Black and poor. Most ignored me, but one day, one short kid turned to me out of the blue, and said venomously, "I don't like yo face." He threatened and scared me and I hated him for it. But at the same time I could read between the lines so I knew exactly what he meant. It was the full package. He hated my opportunities and privileges and his lack of them just for the colors of our faces. I don't know exactly how I knew it. My upbringing surely had something to do with it. My mother was always on the side of the underdog (who was most often my middle brother) and although both parents expressed no love for Blacks they did have sympathy for their plight. So as segregated as my life was, outside of that pool, and as innocent and ignorant as I was of the News, I was surprisingly sensitive to the problems of Race. Kids are a lot more savvy and intuitive than you might think. I have always taken that knowledge into account in my teaching.

My ambivalence about Race continued for decades. I always opposed segregation at the same time that I distrusted, feared, disliked and sometimes even hated some Blacks, or to be more precise, some African Americans. That is not so extraordinary. I remember Dostoevsky writing about one of his characters who loved mankind but hated all people. Attending CCNY meant walking through Harlem. I never felt safe even though it was mostly quiet. But I was a stranger and worse, an invader in a strange and hostile land.

During my student years in the early 1960's the hostility was muted. Returning in 1970 as a young Assistant Professor, you could see the

difference, starting with the graffiti-covered Subways. CCNY was still largely Jewish, but that was CCNY's last Jewish Hurrah. Open Admissions had begun. Standards were trashed and obliterated. All you needed to be admitted was a High School diploma, which meant little in the bad schools, and there were plenty of bad schools.

A demographic overturn in the Bronx and Northern Manhattan combined with Open Admissions to totally change the student population at CCNY, which became largely Black and Hispanic. Throughout the decade of the 1980's I faced quiet but bristling hostility from about 40% of the African American students in the introductory courses that I taught. (There was no corresponding hostility exhibited by Hispanic Students.) This hostility peaked in 1984 in the wake of Jesse Jackson's visit to City College and 'Hymietown' comment. I hated those years and the African Americans who had bristled at me, even though I knew it was not personal. Fortunately, this hostility simply evaporated between 1990 and 1995, but a colleague pointed out to me that the African American presence at CCNY had dwindled. Most of CCNY's Black students were from the Caribbean or from Africa. One coal-black graduate student from Zaire told me that American Blacks hated Africans more than they hated White People.

My last decade at CCNY was great. And strangely, I noticed that, for the first time in my life, I did not always see the color of a person's face. It was a remarkable change. I cannot tell how much of the change was me and how much was the surroundings but it was a very, very happy change.

You can imagine that the decades spent in a largely African American environment left permanent marks in me, not all good. I have seen many aspects of racism and of reverse racism. As a Jew, I am very aware that, to say the least, we have not been beloved either by Christians or Muslims, and that calls for our extermination never cease. Perhaps because of my background, I have long been sensitive to what is called 'dog whistle politics', the coding of racial and religious resentments and restrictions using dissembling lingo. I feel that is far more prevalent and a far stronger driving force behind human relations than most of us would like to admit.

So, I have walked through the arena of life and into the classrooms with a screwy set of sympathies and prejudices. Since I recognized that I came to class with heavy baggage, I have struggled to see through it so that my assessments and decisions could be largely accurate, informative, rational, and useful. I think they have been and are.

Every teacher walks through the arena of life and into the classroom with their own screwy sets of sympathies and prejudices. But what are

we to do about our prejudices? Can we eliminate or at least ameliorate them from within ourselves, and if so, how?

If education could have purged or cleansed us of our prejudices it would have done so long ago. All education can do is point out and make us conscious of the foundations of our feelings, which are extremely difficult to change, and by virtue of making us self-aware, enable us to prevent or tame any bigoted actions. I am not demeaning this limitation given our human natures. It is a giant step.

All the research (and experience) shows that it is near impossible to find anyone who is totally unbiased. So, for starters, it is every teacher's job to keep their little harmful insanities to themselves. The greater their self-awareness, the more likely they can succeed.

What are the roots of prejudice? Prejudice may start simply with two fundamental human traits that are or have been necessary to our survival. First, we categorize. But categorizing leads directly to judging. Second is our strong tendency to be clannish or tribal. We are safe within our tribe and not safe outside it.

I once observed a squabble within a flock of birds. The alpha bird was ceaselessly chasing and harassing one other bird. My first thought was that the harassed bird would have a much easier life if it had simply left the flock. But nature taught the bird well that leaving exposes it to far greater dangers. We humans do not have bird brains, but it is also extremely difficult for us to physically leave or cease identifying and sympathizing with our clans or tribes, and thereby avoiding or setting ourselves against all other tribes.

We in the USA now live in times where it is almost anathema to express racist feelings publicly and very difficult to even acknowledge them. I have lived long enough to remember a time when it was more than permitted, it was fashionable, except among the most liberal circles. Have we Americans changed our inners that much in the past 60 years? Evolution is not that rapid! I am keen to hypocrisy, sometimes even within myself.

Indeed, psychologists have developed a variety of ingenious tests to root out and assess the prejudicial feelings we may well even hide from ourselves. The *Implicit Association Test* is one of the most favored and well known of these. There are many variations, but here is one telling example. Several sequences of two pictures are flashed before the subject taking the test. The first picture is of either a White or Black person holding something. The second picture is either a gun or a tool such as a drill. Immediately after the second picture flashes the subject must choose whether the person in the first picture held a gun or a drill. The computer disqualifies slow reactions – the test is seeking our

unconscious, knee jerk reactions, which are extremely rapid. The results: Almost invariably, the subject is more likely to incorrectly choose a gun when the first image was a Black rather than a White. The tendency is very strong among White subjects but is also present among Black subjects. So, no matter what we say in public or to ourselves, we implicitly are more likely to associate Black people with violence. And modifications of the same test expose our degrees of sex, age, religious, national, political, and sports team discrimination!

As a professor, I performed some of my own similar tests in classes that included statistics. The first was to ask my students for a simple yes or no answer if Pope Benedict's comments in September 2006 about Islam were offensive. One student of 11 asked, "What if you don't know what the Pope said?" I answered that a person who didn't know could abstain. But all 11 voted. Then, once they had voted, I asked them to write on a separate piece of paper what the Pope had said. None knew. Yet 10 of the 11 said that the Pope's comments were offensive. When I revealed that, the students were visibly shocked. It was one of the strongest reactions that any class of mine showed in 42 years of teaching. The students were compelled to realize and admit to themselves that they and their comrades were prejudiced. Prejudice is Science's great enemy.

For the second test (a few semesters later) I asked each of 35 students in the class to list their 3 best friends by first name. When everyone had finished, I told them to denote the sex and race of each friend. There was some question about race, so the class finally decided on 4 categories – Black, Hispanic, White, and Other. Finally, each student had to list their own sex and race. Then we tabulated the results. More than 75% of the best friends were of the same sex and the same race as the students. Statistical analysis revealed that the probability of this happening by chance alone was infinitesimal. Thus there was design in the choice of friends.

I brashly told the students they were all bigots even though Statistics does not give titles or reasons. Naturally, their first question was whether their professor was also a bigot – to which I immediately confessed. Then the reasoning process began. One student pointed out that at least as regards race, most of them grew up in cloistered communities, so that even if they had no prejudices at all, they would be far more likely to choose friends of the same race. Chalk up one for that astute student, whom I praised duly. But the students did leave the class a bit more aware of and a lot surprised about their prejudices, especially as they had always considered themselves solely as the victims and never the perpetrators of prejudice. So, that was one really successful lecture. The students learned the meanings, values, techniques, and yes, the

limitations of statistics. Did it alter their lives or their behavior? I'll never know. But I do know that they left class as wiser men and women with the option to alter their lives or at least their behavior.

Long before I knew or tried anything about these psychological tests of prejudice I tried to assess my own prejudices and tried very hard to be objective as a Professor. I have already expressed my doubts of the possible impact of my personal expectations (not standards) on student performance. I did promise students they had to study hard, but how they performed depended totally on their own work ethic and abilities, and whether they came to my office to go over the sample problems. In a sense, I did not give grades. I only assigned the grades that the students earned and my grading was objective. I almost never saw the students' names as I graded, graded one question at a time for all students to ensure maximum consistency, and looked back where I suspected any inconsistency. Recall the example I gave (see p. 10) to illustrate the point system I used consistently to grade each question over almost 40 years.

*Back to the present!* Regardless of my background and baggage, it took no great insight to observe the sequestering of the troubled Hispanic students into the Integrated Science course. How ironic and misleading a title for a poorly performing and largely segregated class.

### **One year later, Aragon High eliminated 'Integrated' Science.**

Yes, they eliminated 'Integrated' Science. They simply found another course to separate the poor students. Pseudo integration continues apace in the USA.

Where there is blame there is also responsibility. Aragon High is compelled by law to admit the students it does. Segregation follows when a large fraction of the students of one Race or Ethnic Group perform at a decidedly lower level than the bulk of the students. Those Hispanic boys were behind the curve long before they entered High School, and, to their great misfortune, long before they entered Kindergarten. In this way, the school does what it can, given its mandated mission to keep those kids on the Academic track despite the Himalayan evidence that the bulk of them will not succeed academically.

All that the mandated integration can do is to provide the opportunity for anyone to succeed. And it is in this respect that the USA has changed for the better dramatically over my lifetime.

## Wintermission and Retrospective

Around this time, many people asked me, "Are you enjoying Substituting?" When I said, "For the most part, No! It alternates between truce and all-out War," it invited a natural follow-up question, "Are you going to continue doing it?" I had already thought that one out – at least partially. I would stick it out at least through the spring. It does take time to get used to anything.

Back in 1990, Elaine, one of our meteorology graduates, got a job as the TV Weathercaster in Kingston, NY. When she went on a 2-week Amazon River cruise, she begged me to substitute for her. I considered myself a master in the class but have always been camera shy. Just try to get me to smile for a photo. I am Mr. Wooden himself!

I was so nervous on camera that by the end of the first week I had lost over 5 pounds even though I had little fat to lose. I was exhausted. But in the second week I got tired of being nervous. I actually began to enjoy it. Maybe subbing would turn out to be the same.

In the winter interim I had given myself a project aside from this essay. New retirees like Moi need projects to feel relevant and useful. Back in 1992 I began a book I originally thought of calling *Calculus for Morons*. I only made an inspired start, but that is critical. Subbing inspired me to revive, complete and print the book, but change its name to *Calculus: Your Royal Road to Genius*, since it really takes genius to understand the Calculus. I know it won't ever sell, but I think I wrote something really good. It is only 190 pages, which is perhaps 15% of the volume of most of today's bloated Calculus Texts, and still covers almost 100% of the typical 3-semester curriculum. Of course, it doesn't have Distraction Boxes or armadas of problems that swell texts, but it covers the material in a friendly, attentive manner. The book is like an odyssey on which I accompany the student travelers as a guide.

I don't know where *Calculus; Your Royal Road to Genius* will go! I don't know where this Memoir, *Sub Ways* will go! Promoting a book involves much time and effort – precisely the type of effort I abhor. I have been through that route before and don't want to waste more of my life on the rejection circuit. Any book, but probably especially a textbook also involves an incredible amount of polishing that I am not up to.

For what it is worth, *Calculus; Your Royal Road to Genius* has come to some good. It has improved my math subbing skills both because it honed and de-rusted my ancient math skills.

## Day #9: Back in the Saddle Again: Statistics and Pre-Calculus

Math was the subject of my first day subbing in the Spring and for a short while it seems the rowdy students were taking up exactly where they had left me 4 months before. They simply wouldn't quiet down. So, I silently went to the board and wrote in large letters and numbers, "Dean's Office Phone x2901." The noise level abruptly went down by about 60%. But that was still not enough. So I scowled at the class and said sternly, "You have no idea of how good I am. I am too God-damned good to get this trash treatment from you!" It worked! Silence followed.

Now that I had this rowdy class's attention I gave my math sales pitch, addressing it directly to one student. I did this to personalize the financial crisis for the whole class and make them all feel a little like its victims. I wanted them to remain well behaved and attentive. Then I told them how I used simple knowledge of percentages to make money out of nothing from the financial crisis. I wanted to impress them to keep them in line.

"When the financial crisis hit I didn't realize that the stock market was so closely tied to it. So the market went down 50%. At the bottom, I lost 45% of my money. It didn't feel good. But at that point I saw that many stocks were paying annual dividends with much higher rates than the interest rates on loans. So I took \$100,000 from my home equity line and bought stocks that had sunk so low they paid 9% dividend. My home equity line only charged 4%. It was a no brainer – I would be 5% ahead. This was a unique opportunity because 99.9% of the time interest rates on loans are higher than dividends. As a result, in the 4 years since then I have made 5% of \$100,000 or \$5000 each year for nothing! I didn't have to be a math genius to figure that one out. If I could have borrowed 1 billion dollars to invest, I would have, because 5% of 1 billion is 50 million dollars! And that doesn't count the fact that the stocks went up after 2009."

I then asked, "Am I bragging?" A few students said, "Yes!" I agreed. "You bet I am! But I did admit that I lost 45% of my money at the bottom. So I am being honest. And the main point is that what I did many others could have and should have done (and some others did better)."

Having rendered them receptive, I distributed the exercise of the day, which dealt with the quadratic equation, gave brief instructions, solved one of the problems, and the class then went about their business quietly and responsibly.

The next two classes were Statistics. Their exercise was to work with the three measures of *central tendency* – a fancy term for the averages –

mean, median and mode. I began to lecture (after my sales pitch of course) on why we sometimes use mean and sometimes use median.

“I was always taught that to get an average you add up all the numbers and divide by the number of people or cases. Why then would we use median?” I gave the example of 4 different salaries. “You earn \$1000 per year. I earn \$99,000 per year. A plumber earns \$400,000 per year. And Bill Gates earns \$9.9995 billion per year. The mean is \$2.5 billion. That is fine but it is completely unrepresentative. The median is the 50<sup>th</sup> percentile and that tells what the average person earns.”

The class was not one bit excited by this. Their body language and regular language said, "Boring!" It was old hat to most of them. Had I fallen into the trap of showing knowledge that the students considered to be passé? Au contraire! Because this time I was ready for them.

“So you know this stuff already! Great! Your teacher did a good job. Now I’ll show you something new. Statistics is not only concerned with averages but with variations. Tell me the average height of an adult American male!”

The class came up with 5’9”.

“How about the average American female?”

They came up with 5’5”.

“What would you call an adult who is 3 feet tall?”

They argued between midget and dwarf and settled on dwarf.

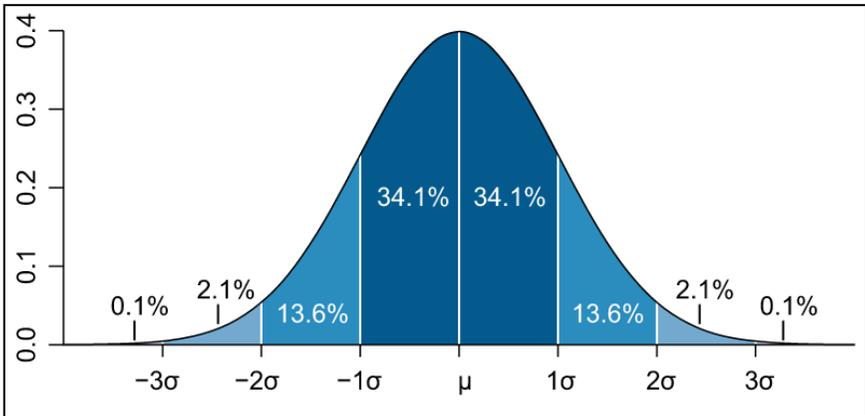
“The dwarf is almost 3 feet below average. If the average is near 6 feet, why is a deviation of 3 feet so remarkable? After all, the Mississippi River is perhaps 50 feet deep in places and it can vary by more than 40 feet from high to low.”

Phrased that way, the students were a bit perplexed.

“The answer is that humans are designed so that the standard deviation is about 3 inches, not 3 feet. The standard deviation is a measure of the size of the typical variation.”

Next, I went on to the normal distribution, commonly called the bell-shaped or bell curve, shown in Figure 6. At least some of them knew of the bell curve because of its relation to the distribution of test grades.

“If you are within 1 standard deviation of the mean – that is plus or minus 3 inches, then there is nothing unusual because that is where 68% of the population is. Only about 16% of American men are taller than 69 + 3 inches = 6 feet. Now when you are two standard deviations above the mean or 6’ 3” you are beginning to get notice. Only about 2.25% of the men are taller than that. How about 3 standard deviations above the mean or 69” + 3×3’ = 6’ 6”? Only about 0.135% or about 1 in 700 men are taller than that.”

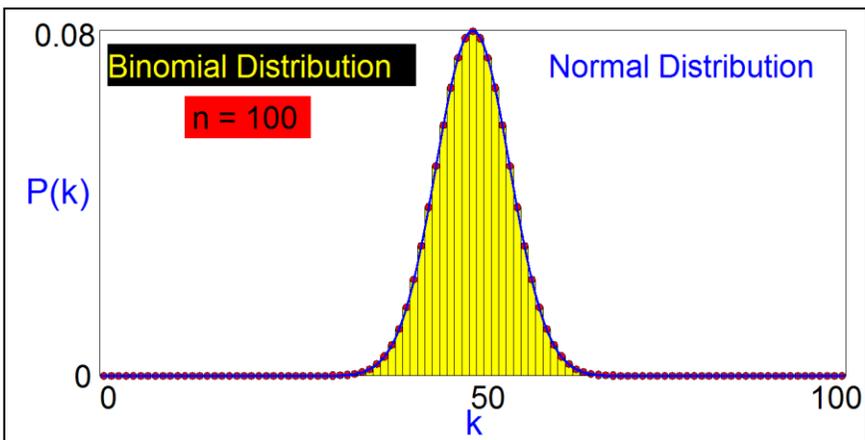


**Fig. 6. The Bell Curve with frequency vs. number of standard deviations.**

In the first statistics class this is as far as I got. I forgot my great bet. In the second class I remembered the bet.

“I’ll make you a bet. Flip a coin 100 times and count the number of heads. If you get more than 75 heads I will pay each of you \$1000. If not, you each pay me \$1. That is 1000:1 odds. Would you take the bet?”

Even though the students were wary of a trick, they found the odds to be irresistible. But they didn’t know about the binomial distribution, shown in Figure 7.



**Fig. 7. Probability of any number of heads for 100 coin flips. Don't expect to get 75 heads!**

“The probability of getting more than 75 heads is determined by the binomial distribution, and is more than 5 standard deviations above the mean. So, the chances of getting that are only 1 in 10 million. That is far worse than the odds of drawing a royal flush on 5 cards in Poker. Don’t take the bet! You’ll lose. It is only a way for me to get rich!”

Yes, that impressed them. I had taken the class many standard deviations beyond the mean. As the period ended and they walked out, I asked each of them a final question, “How brilliant and handsome or beautiful would you say you are?” The answer has to be, “I am 5 standard deviations above the mean – better than 1 in 3 million!” That got more than a few smiles.

The best was reserved for the last two classes – Pre-Calculus. During lunch I scanned the bloated Pre-Calculus text and was astounded to find that neither of the words, Derivative nor Integral appeared in it. How can you write a Pre-Calc text without giving a Pre-View of what Calculus is about? It was incomprehensible to me. I decided to give the students a lecture on how Calculus got started. I went to the computers in the school library, opened my email, found the Pre-Calc Chapter in my book, *Calculus: Your Royal Road to Genius*, refreshed my memory about what I would need, and was ready to go.

During my normal sales pitch for math, I asked my typical questions. This time, one student knew all about the Glass-Steagall act and its repeal. Wow! I complimented him and let the class know that he was the only one in at least 20 math classes I had subbed in and thus the only one out of over 500 students that knew about Glass-Steagall.

Then it was on to my lecture on the origins of Calculus.

"I can't believe that your text does not contain either of the words, Derivative or Integral. Both of them are central to Calculus, and I am going to show you where Calculus comes from."

I then proceeded in order to weave together two math concepts – areas and infinite series.

“The formula for area is length  $\times$  width. Areas are not just used to see how much land you have. They can be used to see how much paint you need to cover a wall or to calculate your total earnings from the hourly salary rate times the number of hours you work.

Then I began calculating areas. I drew a rectangle, showed the lengths of the sides, and asked them to find the area. They responded, “Base times height.” Easy! Then I drew one of the diagonals of the rectangle to divide it into two right triangles and asked them to find the area. Again they knew and could see the answer. “A triangle's area is  $\frac{1}{2}$  base times height.”

"And what if the triangle is not a right triangle?"

I quickly showed how to divide any triangle to two right triangles. So again the area is  $\frac{1}{2}$  base times height. Then the going got tough. I drew a parabola,  $y = x^2$ .

"Curves such as parabolas are extremely important. Parabolic mirrors can focus sunlight onto a point so that it will burn a hole through metal. Parabolic reflectors in San Francisco's Exploratorium in can focus sound so that you can hear your enemies or presumed friends more than 100 feet away whispering about you. Cut through a fox's or rabbit's ears and you will see its shape is a parabola!"

"How do you find the area under a curve such as a parabola? That's tough. Finding the area under any curve is one of the things Calculus does! **In fact, Calculus is the Math of Curves.**"

I knew that the students had just studied infinite series.

"We are going to use infinite series to solve this problem. When Carl Friedrich Gauss, a real math genius, was about 10 years old the teacher punished the class. Add all the numbers from 1 to 100. So the kids took out their cell phones – oops – their little chalk boards and began. Gauss had the answer almost immediately. He had realized that the first and last terms add up to 101. So do the second and next to last terms. There were 50 pairs that added up to 101, so the total was  $50 \times 101 = 5050$ .

"That is an *arithmetic* series. One step up the toughness scale is the *geometric* series, which is the series we will need to get the area under a parabola. To find its sum requires two steps of genius."

I write the derivation that I gave the class below in red. Skip it if you want but you can be sure that I won't put it in a focus box.

"A geometric series is one where each succeeding term is larger (or smaller) than the previous term by a constant ratio,  $r$ . In the series below,  $a$  is the first term,  $ar^n$  is the last term ( $n$  terms later) and  $S_n$  is the sum,

$$S_n = a + ar + ar^2 + \dots + ar^n$$

The first step of genius needed to find the sum of a geometric series is to multiply each term of the series by the ratio,  $r$ . This yields a second series, whose sum is  $rS_n$ ,

$$rS_n = ar + ar^2 + ar^3 + \dots + ar^{n+1}$$

The second step of genius reveals the hidden motivation for the first step. Subtract the second series from the first. Then, as you can see below, every term on the right hand sides cancels except for the first term in the first series,  $a$ , and the last term in the second series,  $ar^{n+1}$ . This gives,

$$\begin{aligned}
 S_n &= r + ar + ar^2 + ar^3 + \dots + ar^n \\
 -rS_n &= -ar - ar^2 - ar^3 - \dots - ar^n - ar^{n+1} \\
 (1-r)S_n &= r - ar^{n+1}
 \end{aligned}$$

At this point, any high school student in algebra can solve to get the general equation of the sum,  $S_n$ , of the first  $n$  terms of a geometric series. Simply divide both sides by  $(1-r)$ .

$$\boxed{S_n = \frac{a(1-r^{n+1})}{(1-r)}}$$

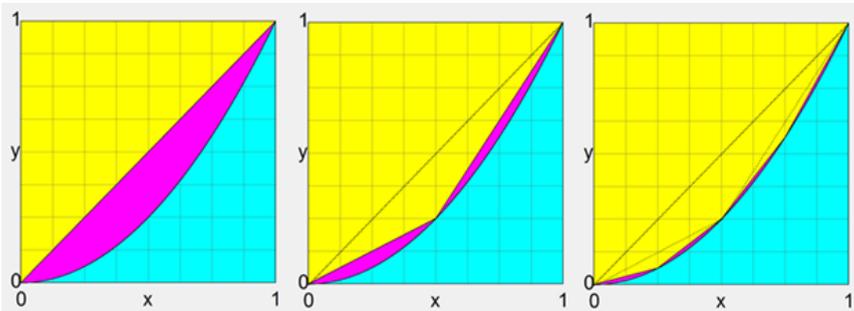
Let's try this formula, using a classic example of the infinite series, where  $n = \infty$ . The first term,  $a = 1$  and the ratio,  $r = 1/2$ . Then the series is,

$$S = 1 + \frac{1}{2} + \frac{1}{4} + \frac{1}{8} + \frac{1}{16} + \dots$$

The sum formula shows that  $S = 2$ . You can also see it without a fancy formula if you note that the  $n^{\text{th}}$  sum,  $S_n$  equals 2 minus the  $n^{\text{th}}$  term. To show this, I highlight the last term in each successive series in red. Thus,  $1 = 2 - 1$ ;  $1 + 1/2 = 2 - 1/2$ ;  $1 + 1/2 + 1/4 = 2 - 1/4$  and so on.

Now, we are ready for the grand finale. We combine our knowledge of the areas of rectangles and triangles with our knowledge of infinite series to find the area under our curve, the parabola,  $y = x^2$  the way Eudoxus did 2300 years ago! His step of genius began with relinquishing the idea of perfection. Since he could calculate the area of triangles, he could find the approximate area under a parabola (or any curve) by slicing away successively smaller (yellow) triangles over the curve (see Figure 8) and subtracting their area from the original square.

Eudoxus began with the square that extends from  $(0, 0)$  to  $(1, 1)$  and began to chip away at it. He drew a diagonal straight line connecting the endpoints of the parabola. This divides the square into two right triangles, each with area  $1/2$ . In the left panel he discarded the upper left, yellow triangle because it lies above the parabola. The remaining area is  $1/2$ . It consists of the turquoise area under the parabola and the excess, purple area. Eudoxus then drew and discarded a second yellow triangle in the center panel because it also lies above the parabola. The altitude of this triangle is  $h = 1/2 - 1/4 = 1/4$  and its base,  $b = 1$ , so its area =  $1/2bh = 1/8$ . The remaining purple plus turquoise area =  $1/2 - 1/8 = 3/8$ .



**Fig. 8.** To approach the area under the parabola (blue) slice yellow triangles away. The residual purple area continues getting smaller.

In the right panel Eudoxus discarded two more triangles that partly fill the two slivers between the previous triangle and the parabola. These touch the parabola at  $x = \frac{1}{4}$  and  $x = \frac{3}{4}$  respectively. Each of these triangles has height  $h = \frac{1}{8} - \frac{1}{16} = \frac{1}{16}$ , and base,  $b = \frac{1}{2}$  so the area of these two triangles sums to  $\frac{1}{32}$ . Now, the purple and turquoise areas sum to  $\frac{11}{32}$ . We can continue this process indefinitely, each time cutting down the purple area and getting closer to the parabola. Each succeeding step doubles the number of new triangles but adds only  $\frac{1}{4}$ <sup>th</sup> the area of the previous triangles. This leads to an infinite series of triangles that ultimately merges with the parabola. Thus, the area under the parabola ( $\frac{1}{3}$ ) is the sum of the geometric series,

$$A = 1 - \frac{1}{2} (1 + 0.25 + 0.25^2 + \dots) = 1 - \frac{1}{2} \left( \frac{1}{1 - .25} \right) = 1 - \frac{2}{3} = \frac{1}{3}$$

You can probably see why this is called the *Method of Exhaustion*. Believe it or not, Eudoxus was at the doorstep of Calculus, yet it took another 2000 years to cross it!

We have found that the area,  $A$ , under the parabola,  $y = x^2$  is exactly  $A = \frac{1}{3}$ . We have done something truly amazing. We have found the formula for the exact area under a curve, which is no simple trick. But the formula itself is really simple and unexpected!”

When I did this derivation in the first period I made one careless error in the infinite series that a student pointed out. (I thanked him.) The class seemed satisfied to learn where Calculus will take them.

For the second class, the derivation went much smoother and the class broke out into spontaneous applause at the end. I was floored. In all the years I taught I got applause perhaps 5 times and one of those was when I came to class in a suit and tie because of a formal event I had to attend after class. Why would a Sub get applause? I answer this on Day #24.

## Day #10: Probability: Choosing Boyfriends and Girlfriends

Today was math again, except for one period of study hall. Students were quiet. This was occurring more and more often (especially in San Mateo High). But never get overconfident, my fellow Subs! The tsunami can strike at any time.

Once again I subbed in Statistics. The topic was probability and their assignment was to calculate permutations. Another day was to be reserved for combinations.

“You learned that there are permutations and combinations. It takes time to get used to the lingo. Here is a handy mnemonic.

1. **C**ombinations are like choosing members of a **C**lub (or team).
2. **P**ermutations are like choosing winners of a **P**rize.

For **C**lubs, it doesn't matter whether you choose Jack or Jill first. For **P**rizes the order does matter: Jack won first prize – he fell down and broke his crown – while Jill only won second prize – she merely came tumbling after. So, while there is only one **C**ombination (Jack and Jill), there are two **P**ermutations, (Jack then Jill or Jill then Jack). And once there is more than one prize or one club member, there are always more permutations than combinations, **P** > **C**.”

I did some simple examples and the class seemed to be with it. Then I switched to Poker.

“Permutations and combinations are the keys to finding odds in card games. Take 5-card stud poker, where you get 5 cards and cannot turn in and draw any more. There are 52 choices for the first card. Since you don't replace cards when dealing a hand, there are only 51 choices for the second card, 50 for the 3<sup>rd</sup> card and so on. Thus the number of **P**ermutations of 5 cards is  $52 \times 51 \times 50 \times 49 \times 48 = 311,875,200$ . But since a hand of cards is like a **C**lub because the order of picking the cards doesn't matter, we are looking for how many **C**ombinations there are. So we must find how many ways there are to pick the same hand. For any hand of five cards there are 5 ways to pick the first card, 4 ways to pick the second and so forth. Thus there are  $5 \times 4 \times 3 \times 2 \times 1 = 120$  ways to arrange (**P**ermute) any hand. So, the number of different 5-card poker hands is,  $311,875,200 / 120 = 2,598,960$  hands.

How about a special hand, such as a Royal Flush? There are  $20 \times 4 \times 3 \times 2 \times 1 = 480$  ways to pick a Royal Flush. How did I get this? The first number is 20 since you can pick any of the top 5 cards in any of the 4 suits. But once you have picked the first card, you must stick to the same suit so there are only 4 choices left for the second card, 3 for the 3<sup>rd</sup>

and 2 for the 4<sup>th</sup> card. The odds of being dealt a Royal Flush are therefore 480 out of 311,875,200 = 1 out of 649,740.

In all my life I have never been dealt a Royal Flush. My only consolation is that I know how to write a computer program that can deal out poker hands. Computer programs run so fast that they will surely deal me several Royal Flushes every second. I won't look at the losers."

Then, as the students did their assigned exercise, I came around the room asking what they were going to do next year after they graduated. As I was doing this, another example of probability occurred to me so I asked the class to solve it.

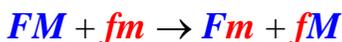
"Imagine that you can choose 5 girlfriends or boyfriends of your very own from this class. How many different groups are there?"

No one had the slightest idea how to do it. The example stunned them and they could not even think of how to answer it. That stunned me, though I guess it shouldn't have! I thought they would immediately see it as an example of a **C**ombination, just as a **C**lub, a team or a hand of cards. But they didn't! Very likely, the thought of a group of their own sex slaves completely distracted them from realizing the purely mathematical nature of the problem. It is always extremely difficult to switch mental gears from one field to another.

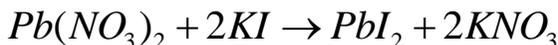
## Days #11-12: The Right Chemistry

This was the first time that a teacher phoned me to ask if I would sub for him. Mr. AA was to be absent two consecutive days. Since I am not fresh in chemistry, I made an appointment with him so that he could give me a tutorial regarding the laboratory on solubility to determine something called the solubility product. Whoa! I never studied the solubility product in high school and I never encountered it even when I took College Chemistry. So Mr. AA gave me background and then led me through the lab. It involved what is called a substitution reaction.

What is a substitution reaction? Imagine starting with two pairs, Capital *FM* and small *fm*. Imagine that *M* and *m* and *F* and *f* swap partners so that the final pairs are mixed *Fm* and *fM*. When this happens with chemical pairs (molecules) the reaction is called a substitution reaction. Writing it as a chemical equation looks like



Mr. AA had to prepare his chemical pairs carefully. He chose Lead Nitrate,  $Pb(NO_3)_2$  and Potassium Iodide,  $KI$ . Both were clear solutions. But when he poured them together, Presto! The mixture immediately turned cloudy yellow because of a yellow solid that precipitated. The chemical equation for the reaction is,



Both the Lead Nitrate and the Potassium Iodide solutions were quite dilute – only 0.02 Molar (the number of moles of dissolved material or solute per liter of solution). The students were assigned to different lab groups. Each group was instructed to mix a preassigned volume of each of the initial solutions. The first job was to calculate the number of moles of each chemical. As an example, Group 1 was told to measure 2 milliliters (ml) of Lead Nitrate and 4 ml of Potassium Iodide. Since 1.0 liter has only 0.021 moles of Lead Nitrate, 0.002 liters has  $0.002 \times 0.021 = 4.2(10)^{-5}$  moles. Similarly, there were  $8.4(10)^{-5}$  moles of Potassium Iodide.

The way to determine the solubility product is to add water to the new mixture until all the yellow precipitate dissolves. Of course, you have to measure how much water you add. That turned out to be 64 ml. The next question is to find the final volume of the solution. Since there were 6 ml initially and they were almost all water, the total volume was 70 ml. The new molar concentration of each component was  $4.2(10)^{-5}/0.070 = 6(10)^{-4}$

M (M stands for Molar) for Pb and  $8.4(10)^{-5}/0.070 = 1.2(10)^{-3}$  M for I. Now we have all the terms for the Solubility Product

$$K_{sp} = [Pb][I]^2 = 6(10)^{-4} [1.2(10)^{-3}]^2 = 8.84(10)^{-10}$$

By the time of the class I had enough confidence to help the students with any questions they had with the lab. It reminded me of the saying, "Genius does what it must, talent does what it can and students do what they're told." I was the talent (no way the genius) in the position of authority and had to be knowledgeable. The students were allowed to have doubts and questions. Their level of responsibility was several notches lower than mine. (Note the issue of responsibility!)

I enjoyed learning and could tell several things about their teacher, Mr. AA. He had high expectations of his class and did not easily give them answers. He also lectured quite rapidly to me so that I had to slow him down. The students wouldn't be so proactive, which would cause them problems – if he lectured to them as quickly as he did to me. That, of course, I don't know.

The lab took up the entire time on the first day. The second day was devoted to finding the solubility constant. I decided to add a short lecture about solutions.

"Solutions are everywhere and are critical to life. The ocean is a giant solution with dissolved salt and CO<sub>2</sub>. Seltzer is a much more concentrated solution of CO<sub>2</sub>, but there are still tons of CO<sub>2</sub> in the ocean – 40 times more than the CO<sub>2</sub> in the atmosphere that causes global warming.

My new granddaughter Charlotte has a rare genetic condition called hyperinsulinism. It is the opposite of diabetes. Her pancreas never turns off producing insulin, which removes her dissolved blood sugar so that it quickly disappears. Before school today I looked up solubility of salt and sugar in water. At 25°C a saturated solution of sucrose is 12 M or 2200 g per liter and a saturated solution of NaCl is 6 M or 350 g per liter. How about blood sugar? The normal concentration is about 0.0055 M. This is about 1/2000<sup>th</sup> of a saturated solution. If it drops below 0.0020 M then you will suffer from hypoglycemia, which lowers energy level and can, if sustained for a long time, lead to mental retardation and brain damage. If it rises much above 0.2000 M and persists it can lead to diabetic shock, coma, and death. Fortunately, diabetics now can take insulin and Charlotte is constantly dosed with sugar and monitored for her blood sugar."

I suddenly got a brain storm on an analogy to illustrate the substitution reaction. Analogies can mislead, but good analogies are extremely useful teaching and learning aides. I used them often throughout my career. In this case, I asked for two girl volunteers and one boy volunteer to join me at the front of the room. We then formed two couples. I was Potassium and Girl #1 was Iodine. (Name tags would have helped.) The boy student was Lead and Girl #2 was Nitrate. Then I told the class I was tired of my lover (Girl #1 = Iodine ) and changed to the other lover (Girl #2 = Nitrate) while the boy gladly took Girl #1 as his new lover. The class enjoyed the analogy. Some days later I told my brother, Robert, who teaches Chemistry and Biology, about my brainstorm. Lo and behold, he used the same analogy to illustrate substitution reactions. Perhaps it's a family trait. More likely, many Chemistry teachers use this borderline risqué analogy.

That day I also subbed in a math class – Algebra 2. The kids were far better at calculating than were my liberal arts students at CCNY, many of whom could barely add and certainly could not multiply two single digits without a calculator. But the Aragon kids had problems with discipline and stick-to-itiveness! They couldn't seem to solve a quadratic equation using the quadratic formula. They might do part of it, but did not have the staying power to,

1. Write down the given problem quadratic equation.
2. Rearrange it to find the values of the coefficients  $a$ ,  $b$ , and  $c$ .
3. Plug these values into the quadratic formula.

They tried to skip steps and invariably got lost or stuck. Slow but steady wins the race actually works until you really know a subject. They just couldn't accept it.

I almost reached a few of the students. But their brief moments of insight were followed by paralyzing self-doubt. They just couldn't follow through. On the second day all but one student remained morosely silent. And one of the girls that I had almost reached was absent.

\*\*\* An Important Question: Can you think of my motive for including all that chemistry (aside from possibly showing off)? If you skimmed over the chemical equations, think why you did so. I'll bet you skimmed because it is such tough, technical material. You'd have to strain your brain to understand it, as I had to. Now, think of the students who have to strain their brains on such material day after day in different tough subjects class after class. Perhaps you can begin to understand, sympathize with and, recall their plight. Next, think of the teachers who are expected to inspire these exhausted students. Finally, think of the poor Subs, victims of the students' dire need for a respite from their daily, dire struggles.

## Day #13 Social Science without Hyperthymesia: The Sub's Trump Card

For the life of me, I can't remember a single thing about this day. I either lost my brief notes or didn't take any. Clearly, I don't have hyperthymesia.

Now you might be asking, "What in the world is **hyperthymesia**?" If you are I am proud of you. If you looked it up I am even prouder. I didn't have any idea of what it is. A few weeks ago someone told me about a woman who could remember what she wore, what she did, and where she was every day of her life after the age of 13 or so. There are fewer than 50 people in the world with that extraordinary condition or talent.

Hyperthymesia is a remarkable testament to the potential of human memory. However, all those crowding memories can be a burden on the brain. They certainly have the potential to interfere with cognitive function. Maybe the rest of us are lucky we don't have such extravagant memories.

What's my point in writing this? The same as my point in Subbing! Surely, most kids will forget most of their days in school. They will even forget many of the really great or really rotten days. But I am in the game to make an impression – to do something that will stick with the kids. Maybe, just maybe, some of those kids will remember the odd-ball Sub who actually knew something of the material and tried to make a difference under fire and who made a point that stuck and that turned them on.

Why should a Sub be memorable? Think of your early memories. They usually involve something out of the ordinary – a time of a discovery, a triumph, an unusual place or setting, or something unexpected, traumatic or even tragic. You may well forget most or even all days you spent even with a great teacher because even they become routine. But a crazy Sub can stand out enough from the routine or expected to create a lasting memory! That is almost surely why I got the applause in the math class. The students never expected knowledge of an ignorant Sub.

And that precious surprise factor is the Sub's chief trump card!

## Day #14: The Blind Side of Math

This was a poor math class, so who cares about attempting to teach them math? Certainly not their regular teacher! And certainly not their Sub (Moi), who knows any attempt would have been counterproductive at best.

My assignment was to show the movie, *The Blind Side*. What in the world *The Blind Side* has to do with math I will never be able to figure out, but I didn't fight it and went with the flow.

Just as the teacher had predicted in her note to Moi, the Sub, they walked in loud and took some time to quiet down, so I read out loud to them exactly what she had predicted. This had a strong impact on them. I then had them write a paragraph about an incident where they displayed or felt great personal self confidence. Some of the boys grumbled but became intrigued when I told them I am writing a book about my experiences as a Sub. They asked if they would be in the book. I told them if their essay was good enough they might well make it.

Most of the boys wrote about a conquest in sports. One boy wrote how he is ashamed of his body hair but when everyone took shirts off – perhaps at a pool party – he relaxed and it was no longer an issue. Good for him – he learned he is human and that knowledge of facts is important. One pretty Hispanic girl (most of the students in this poor math class were Hispanic) stonewalled the assignment. I guessed that her sense of shame was too great to write anything. Or maybe she couldn't write. I hope I am wrong on both accounts.

When taking attendance, the class told me that one of the absent students had just given birth. I reacted immediately, feeling sympathy for the fact that her life is bound to be difficult and told the class to be good to her and help her when she returns. They really felt what I said. Although it had not been my aim, they felt my sympathy and we bonded. It was a good day.

## Day #15: Return of the Prodigal Sub! Write your Video Games!

The end of the year is approaching and I returned to the math class that gave me much trouble earlier in the year. I was simultaneously a bit tougher and more lax. I was only tough when taking attendance. When one of the algebra classes refused to quiet down I told them about the classic marshmallow experiment as revenge. I followed that with...

"You may well not like what I am saying. I am only an interloper but I can see clearly the consequence of your actions. You don't do or attempt to do the work. You don't realize that you are living in a bubble here in San Mateo, so close to Silicon Valley. Everything is expensive here. I own a condominium in Florida that may be worth \$100,000. Here that wouldn't even buy a parking space. And the bubble here is largely due to the math skills of the people here. Ignore it at your own risk. I am not supposed to say these undiplomatic, politically incorrect things, but I've got nothing to lose and I might actually wake one of you up."

That actually got to them and we sort of bonded. One group of students was doing a project on Peer Pressure and asked me how they might illustrate it. I offered many suggestions, which they rejected one by one. But in talking back and forth, we gradually converged on something they liked. They would run two tables, each distributing the same thing, such as popcorn. Shills would line up at only one of the tables to see if it attracted a larger crowd. They also liked one of my ancient ideas, namely that a storeowner should hire the Prom Queen and King to attract high school customers.

But the best connection was made completely by accident. In the classes where I have nothing to do but hand out an assignment for work they already know well or for practice for a test, I often take attendance by walking around the room and asking each person his or her name. When the class consists of seniors and juniors I ask them what they want to do when they get out of high school. Certainly by the end of the senior year most already have been accepted to college. Many know what they will major in but some have little or no idea. I then follow a sequence of questions that might help aim them better. "What do you like?" If that doesn't work my next question is often, "If I gave you \$5,000,000 so that you don't have to worry about money or choose your major based on it, what would you do after you finished partying and travelling?" That usually has success. A last resort is, "What subject(s) do you hate?" That can also provide direction. If you hate South, head North.

Some students have multiple interests. "That's good! That's what college is about – finding what you love. Take a range of courses, see

which ones you like most, and follow them up." I think I do the students some good with such advice and encouragement.

The serendipitous encounter occurred during one of these questioning sessions. When I asked one boy what he liked the answer was, "Video games."

I responded, "Everyone likes video games." Then I got a brainstorm. Do you want to make video games? I've written some! They're much fancier than when I started writing them but the basic principles are the same. To animate, draw an object, then erase it and draw it in a new position. If there are two objects, keep them moving until they are about to collide. This occurs when both the left-right distance,  $x$ , and the up-down distance,  $y$  between them are small. Once the total distance, which is given by PYTHAGORAS  $(x^2 + y^2)^{1/2}$ , is less than some tiny number either change the direction of the objects so that they bounce, or make them split or explode. So, a great value of math (and Pythagoras) is that it is a crucial part of all video games!

This perked the ears of a girl sitting next to the boy I was talking to. She had been eavesdropping and had gotten sucked into the subject too. So, a light turned on in two kids.

## Days #16-17: Spanish: Cognate = Cognado: The Question of Questions

### Prelude: Our Problems in Teaching Foreign Languages (i. e., not English)

Proposition #1: Most schools in the USA teach foreign languages abominably.

Proposition #2: The schools are not to blame for teaching foreign languages abominably.

Proof for Proposition #1:

Q1: What do you call a person who speaks two languages? A1: Bilingual!

Q2: What do you call a person who speaks three languages? A2: Trilingual!

Q3: What do you call a person who speaks one language? A3: **American!**

QED

.....

Proof for Proposition #2:

In most USA school systems, foreign language teaching has been deemphasized, delayed and downplayed as a matter of political and educational policy. Most states have ZERO foreign language requirements for a high school diploma. Some states accept sign language or computer languages as substitutes. So, many schools teach language abominably because they don't teach it at all.

The best way by far to teach and/or learn another language is immersion starting at an early age. In the tiny but growing number of American schools where this is done, most of the kids do become fluent.

QED

.....

As the end of the school year approached, I felt I had gained enough experience as a Sub to substitute for two days in Spanish, so I summoned the courage and answered the call.

But before describing these two days, I interweave my experiences and thoughts on acquiring another language, because in struggles and sufferings some valuable and universal truths emerge.

## **My Forays into Foreign Languages**

It is 1955 and I am 10. I am in my 3<sup>rd</sup> year class of Hebrew School. I am there after Public School from 3:30 PM to 5:00 PM 4 days a week. I am learning so slowly and so little, I bitterly resent the wasted time, which I could better spend playing handball. I struggle to read the strange printed Hebrew letters and write the equally strange cursive.

I recognize that I am slow in symbol recognition; I was a slow starter reading English in First Grade till I magically caught on at some point. I see that the mind has two distinct operating modes – the slow, arduous deliberate mode and the rapid, effortless, unconscious automatic mode. Making that metamorphosis is the miracle and I could never do it in Hebrew.

Why? We focus on prayers in Hebrew class. Otherwise all teaching and speaking is in English. There is one good. Hebrew grammar is taught. From it I discover that language has structure and each has its own. I am amazed. English grammar is not taught in Public School.

The Hebrew school class gets rowdy again. The distraught teacher is at her wits end. She shouts, “Sheket B’vakasha!” [Shut up please!] We laugh all the louder. Years later I realize that “Sheket B’vakasha!” was the longest spoken sentence we ever heard in all the years of Hebrew School, except, of course for the chanted Hebrew Prayers. No way could I ever have understood even the simplest, slowly spoken sentence after five years of Hebrew school.

Immersion is the only way to learn a language. My two oldest granddaughters have been going to Fiesta Gardens, a Spanish Immersion school, since each was 3. Alexia, 8 (in 2016) is near fluent and Naomi, 6 is well on the way. When Naomi was 4, after several months in preschool class she suddenly began talking nonsense Spanish. The words sounded Spanish but were not real Spanish words. She was getting the flavor of the language before she accumulated the vocabulary. This stage lasted a few weeks and then she began acquiring real Spanish words.

It is September, 1956. Even though it is the second week of 7<sup>th</sup> grade I am in Spanish class for the first time. I missed the first week through some administrative snafu plus a few days of absence. It seems the teacher is speaking a foreign language. I have already fallen behind and feel lost. I am very unhappy. I wanted to learn another language and now it seems an unattainable goal. A lesson I take to heart is when starting a new language, give yourself a head start. Study ahead!

It is 1960. I am in Spanish class in the spring semester of my junior year in high school. Mr. Leventer is a tough teacher, one of my all-time great teachers. He gives a quiz every day. You can’t kid around. At long last I am beginning to learn some Spanish. I am tempted to take AP

Spanish in my senior year because Mr. Leventer will be the teacher. But I opt out because I feel I will be too busy. Big mistake! And I know it!

It is 1961. I am a freshman in college. As a science major I must take an acceptable language such as German. I study ahead. For the first month I am one of the class geniuses. So I get lazy, coast, and fall back in with the mediocrities. The lesson: Stay ahead of the game.

It is June, 1978. I am about to spend a sabbatical year at the University of Tel Aviv in Israel. I hope to finally speak and understand Hebrew. The years spent learning to read and write Hebrew letters as a child did do some good after all. They gave me a jump start.

I buy a few books. The most valuable, other than a Hebrew-English dictionary is a child's picture dictionary. I memorize word groups such as for foods, colors, and animals.

It is November, 1978. I am now in Tel Aviv and can order in a Chinese restaurant where they only speak Chinese and Pigeon Hebrew. I take my 2-year old son, Evan to the Tel Aviv zoo several times. I know almost all the common animal names (and still do).

It is February, 1979. My new friend, Morris finally convinces me to visit his Ulpan Hebrew class. Immigrants come from all over the world with their different languages and assemble in classes after work to learn Hebrew by speaking Hebrew. We sit in a large circle. Dahlia, the teacher chooses the topic of the day and the first person to speak. The topic that day, by sheer chance, is animals. The first person starts. "My name is Ruth and today I saw a large dog." Then the second person goes. "Ruth saw a large dog today. My name is David. Yesterday I saw a black cat." Next is the third person. "Ruth saw a large dog today. David saw a black cat yesterday. My name is Sarah. I saw a small bird." This process is cumulative. You have to listen and remember. When they got to me I told them about the animals I saw in the zoo. I was the genius that day and greatly impressed Morris. Dahlia was impressed too. She told me I am accepted in the class.

That was the first, last, and only day I was class genius. For six weeks I had a Hebrew headache. I was terrified of Dahlia. What a tough teacher! What a fantastic teacher! Imagine – a Jewish Nazi. The next term we are assigned a new teacher. No more circle. No more learning.

Out on the street I speak some practical Hebrew. How do I speak? I compose sentences in English in my head and then translate word by word any way I can manage given my limited Hebrew vocabulary. I then speak the sentence quickly so that it sounds pretty good. But any listener must wait patiently for the next sentence.

When people speak to me they don't stop after each sentence to wait for me to process and translate it. It's much too fast for me. Not only am

I very slow in symbol recognition, my ear for the spoken word in a new language is also slow. My problem is compounded by self consciousness the moment people speak to me. My wife, Bernice is far better at understanding. But she can't speak as well as I can. So she translates from Hebrew and I speak Hebrew.

By May I am beginning to get it. I visit the matriarch of my parents' Israeli friend. I sit quietly as she converses with another woman. I don't understand a single word. When the woman leaves, I tell the matriarch in Hebrew I feel terrible that after six months I don't understand anything. She says, "Don't feel bad, we were speaking Farsi!" Then we visit my older cousins, Shragga and Rinna. They begin to argue in Hebrew. Suddenly they look at us, realize we are beginning to understand, and immediately switch to Polish. [Shragga was fluent in 11 languages.] That is one of the greatest compliments of my life.

It is April 1999. We are in France where our daughter, Elise is doing her sophomore year abroad at the University of Tours. Elise is fluent in French; I don't speak and barely understand a word. I fear being spoken to and displaying my ignorance in French. So, when I shop I keep a low profile, neither attempting to talk nor listen to anyone. I get by because I can count.

We have just left the awesome Chartres Cathedral. I drop Elise and Bernice in a one-way, one lane medieval street to get crepes. It takes 25 minutes to find the way back through the labyrinth. I am steaming mad. We stop for France's gougely overpriced gas. I need a bathroom. The gas station has no bathroom. Nearby Bon Marche has no bathroom. I am even angrier. I storm into a Pharmacy. I scream snottily that I need a bathroom, a toilette. They think I am crazy, let me in and let me leave. Then, something miraculous happens. A language window in my brain opens for a moment. It is almost as if I understand what is being said despite my complete lack of vocabulary.

I recall people I know with pronounced language ability say that to them, hearing a foreign language almost sounds like hearing music or a strange accent. Yes, fluency in a language is akin to playing an instrument by ear. My anger allowed me to be receptive because for a few moments it has erased my normal self consciousness.

Clearly my omnipresent fear of appearing stupid and vulnerable to humiliation retards and impairs my slow linguistic processing. Fear of humiliation and self-consciousness diminish the ability to learn any subject. After all the years as a student and as a professor I should have outgrown those twin plagues but clearly have not. As a professor, I observed these plagues in my students countless times and pointed it out to them. They begin to infect us in childhood but positively bloom at

puberty, holding on tenaciously despite our best efforts throughout our adult lives to purge them. And these plagues are surely crucial factors in the documented reduction of language acquisition skill that occurs at the onset of adolescence.

Now it is the spring of 2007! Every day on the drive to work I listen to and shout answers to questions on the Spanish learning tapes my son, Evan gave me. I am preparing for what will be my last sabbatical, this time at the University of Granada in Spain.

My colleagues and friends at the University of Granada are remarkably patient while I haltingly attempt to converse. They help my endless needs endlessly. Professor Jose Antonio Diaz talks slowly and even waits with a smile and without rolling his eyes while I look up words. I am 62, so it takes much more effort and repetition to learn and retain new words. I recognize that I have less ability with accents and less innate acceptance of a language's grammatical structure and essential logic than when I was young. Some words I simply can't get. Stop = *parar* and grab or gather = *coger* were two especially tough ones for me. Conjunctive adverbs such as already = *ya* and still = *todavía* still give me trouble.

The words that stick best by far with me are the cognates (*cognados* in Spanish), the sound-alike words that have morphed from one language to another even if they have changed meaning. Cognates are of no use when a baby acquires his or her first language, but they serve my ancient mind faithfully as both hooks and anchors and provide an almost musical link between related languages. Cognates probably become more important with age for learning related languages but they are useful (and underused) when we are young and studying a language in school. However, there is a limitation with cognates in learning Spanish. They tend to link to our literary words, since the more literary words in English tend to come from the Romance languages whereas the more pedestrian cognates of everyday conversation tend to come from German.

Out on the street in Granada a deranged man is venting in Spanish. Everyone else speaks too rapidly for me to understand. He I understand! I know I should hire him as a tutor but I chicken out.

I have an observation that almost surely relates to how our brains work when learning a new language. Throughout the months in Spain, as I was intensively trying to learn Spanish, almost all memory of Hebrew vanished. But it wasn't erased. A year or so after leaving Spain the Hebrew memory returned without the Spanish suffering much. Thus, the intense mental effort to learn Spanish closed one mental river channel to better open another. I did, of course, automatically conflate some

Hebrew and Spanish words during the year in Spain. When I did that I had to laugh but it must have really confused whomever I was speaking to.

### **Back to the Present**

I pondered these thoughts about language acquisition when I accepted the call to substitute in Spanish. Of course, I was nervous as **H** hour approached. To add to my worries I was assigned an extra double period right at the start of the day because at the last minute a second Spanish teacher called in sick. So, without a minute's preparation for the lesson of the day I arrived breathless in class. Fortunately, it was only Spanish 2, the second semester. The Spanish teacher from the next classroom kindly introduced me, departed the scene, and the day started. The students had a clear assignment that even I could understand.

With great hesitation I began taking attendance. "Johnny Appleseed?" "Here!" After about 15 names, I began to relax and my mind opened. I began demanding that they respond, "Aquí!" I also asked students had Hispanic names, "¿Habras español?" and added "¿con fluencia?" – which I thought meant fluently. Oops! Later, the dictionary revealed that the proper term is con fluidez. Fluencia translates as creep. Ugh! This mistake illustrates perfectly that teachers first must know their subject. Pedagogy is second.

The students who confessed they spoke Spanish did all they could to fade into the shadows. I am not shy of embarrassing students if I can bring it to some good. For years, my standard line to bring shy students out was to repeat, day after day, “**Better to be humiliated before the test than on the test.**” And that line often worked to overcome instances of learning paralysis.

Of course, if you only have a single period with a class the probability of converting embarrassment to good is small, so I didn't push. But I do not think I could have done much harm because such students are already damaged goods. And a factor of paramount importance is the teacher's *intention* to do good. At some intuitive level most students will see that.

I spoke to the class of the importance of knowing a second language and that I wished I did. I gave them in meandering form my background in Spanish. If a story meanders too much it is not good and I somewhat botched it. I failed to turn it into a compelling story.

As the hour went on, it gradually dawned on me that the Hispanic students had no pride in their extra ability, knowledge, or skill. They had only shame – sociological shame. Their names branded them at the bottom of the social and perhaps academic order. Oh, well, I tried. If I

had more time I might be able to do something, but then again, maybe not.

The next day, the teacher, call her Ms. Romanoff, ran into me probably looking for the other teacher I was substituting for. With her, I made two quick mistakes. First, considering her Russian sounding name, I asked if she were a native Spanish speaker. "No!" Then, when I told her of my observation about the shy students, she was all over me.

**"Don't you think we know that? These students have been carefully screened and categorized. Some of them have heard Spanish but cannot speak it. Others are 'classified' and placing them in such a class is intended to give them confidence."**

So, I, a lowly outsider SUB had the gall to tread on established, proprietary turf of the 'REAL PRO' – the regular, certified teacher. She gave me the facts but, 1: did so with a flamboyant display of umbrage at my observation as if it were a judgment on her, and 2: added nothing to my knowledge. The entire sequence may have set her off, but I was not native speaking in Meteorology or Math. I had to learn it along the way and I am proud of what I learned. There is nothing wrong with learning Spanish later if you achieve fluency. If you do and if you are a good teacher I (and any good Principal) would be glad to hire you. If you aren't fluent, I wouldn't hire you to teach a language, no matter how good an 'educator' you are. I wouldn't hire myself in that situation. And I was really asking for confirmation and more explanation about my observation of the self-effacing students, which she could have provided. This teacher lost the opportunity to teach me something.

Did I do any good in class given my limited Spanish and linguistic ineptitude? I think so. I had the kids read their assignment out loud. They clearly needed the practice in reading Spanish. When one kid read the brief conversation with poor inflection I asked him to imagine himself an actor and read it like he meant it. The students then asked me to read it, so I did, and with excess inflection. That loosened them up.

After the reading section which they had to transcribe in Spanish and then translate to English, came a series of questions and exercises. One series of statements was preceded by the question, ¿Cierto o Falso? [True or False?] I noticed, as is my wont as a minor master of puns, that Cierto sounds like Cerdo = Pig or Pork! So, in place of Cierto I offered Cerdo and translated it. Some kids had no reaction but several liked it.

That led my thoughts back to cognates, and to the larger question of how we learn languages. I told the class about cognates and gave a few examples, including cognados en Español, and more obscure cognates

such as *peligroso* for dangerous (perilous). I pointed out that cognates helped me acquire Spanish given my dismal ability to learn new words at my advanced age.

One girl got so excited that other students made fun of her. She couldn't help helping others. (On the side, I told her that a good teacher lets the students think for themselves.) But she was interesting and her enthusiasm was infectious – certainly to me. Every class needs a person like that to liven things up. Brought up in France, she is fluent in French and English, so Spanish, as both a third and a related language, was coming naturally to her. Chalk up another plus for being bilingual, which, in addition, research has shown to stave off the effects of Alzheimer's disease.

I enjoyed the first period and then went on to my normal substituting load. Teacher B had 3 double periods that day, first of Spanish 2 and the next two of AP Spanish.

What that meant was 3 videos. The first video was *La Bella y la Bestia (Beauty and the Beast)*. The students had a sheet of questions to answer. The video for the AP classes was a clear indication of the great advances they had made in Spanish – *Shrek*. The AP students were not assigned any questions – they had just taken their AP tests.

Towards the end of the first double period I had another revelation. When students asked me “May I go to the bathroom”, I began to answer, “**No entiendo inglés.**” [I don't understand English!] It worked. They stuttered their way to fluency. “Puedo ir al baño?” “**Por supuesto!**”

As show time approached I recalled Bruno Bettelheim's classic book on the psychology of fairy tales and their meaning and significance to children, *The Uses of Enchantment*. I wrote it on the board and mentioned it to all the classes I showed fairy tale movies. In all but one of the classes the kids reacted as if I were from another planet. One girl asked how long the book was and when I said, “**About 300 pages,**” you could see her whole body sag. So I added, “**You don't have to read it all – you can choose the story you want.**” Too late – the damage was done.

On Friday, the first class had 3 obnoxious students. Boy #1 immediately sat down in one of the teacher's two rolling chairs and zoomed backwards across the room. He asked if it were OK and I said, no. He grumbled, gave a snotty look and joined the two other problem students to form a clanging troika. I could hear them horsing around over the immense volume level I raised the video trying to drown them out. Despite asking repeatedly, “**Tranquilo, por favor,**” they persisted.

Finally, the two boys began getting physical with the girl. Her protest and noise level increased, yet mysteriously it failed to occur to her either to move away or ask them to. So now *I* was pissed off. I told them to

split up or I would send them to the dean. They didn't budge. So I told Boy #1 to move.

"Why?"

That was all it took, a clear case of obdurate defiance. So I wrote him a pass, called the Dean of Death (who, on Day #0 had told us fledgling Subs that he didn't want to see any students from us) and sent him on his way. I then told the other boy to move. Once again I got,

"Why?"

So, the other two went to the Dean of Death. Surprise: he wasn't cordial. "You are sending me half the class!"

His math was a bit off given that a long computer program proved,

1. 3 out of 30 = 10%
2. Half = 50%
3. 10% < 50%.

What the hell is his job anyway? We all know Subs have precious little authority. I keep the kids so long as I retain some vestige of it. But those boys' "Whys?" was the icing on the cake of open rebellion. I needed a higher authority. Ultimately, even the Dean of Death has little authority. Disruptive kids go right back to the next class.

A fatal flaw of the public education system is that school is considered to be a right for all kids, no matter how disruptive they are. Perhaps! But education should be treated as a privilege and I have always felt strongly that to be in my class is a privilege. So I sent them out and would do it every time.

Later that day I went twice to try to meet the dean but the first time he was patrolling for lunch and the second time, for dismissal. So I never did meet him. If we had met I would have told him off and he would have told me off. I am sure he is much better at it than I am but I had much truth on my side. His job, as I see it, includes backing up Subs when it is necessary. What he sees as necessary is different than what I see. The only kids he wants to see are the murderers or their victims. Then his job is easy – no legal problems for him except to explain why he let it go so far.

I was peeved but don't get me wrong – I'd hire that Dean of Death in a heartbeat.

This whole incident was set ablaze by the kid's 'simple', 'innocent' question – "Why" – and my strong reaction to it. But the question was neither simple nor innocent. Indeed, the question of questions brings up a whole sub-universe of human behavior.

Later, I took some time to compile a list of different motives for asking questions. We have all encountered all of these and more in our lives. All reveal the complexity of the human mind.

## Motives for Asking Questions

1. **To obtain information, knowledge, understanding, wisdom.** 1: “What was the population of San Francisco in 1950?” The teacher may insist that students answer such simple information questions for themselves. 2: “Why did President Abraham Lincoln wait until 1863 to issue the Emancipation Proclamation?” Teachers can use such thought provoking questions to form an excellent basis for dialog and investigation. 3: “Why do like electric charges repel and opposite charges attract?” Some questions we cannot answer and the teacher should state the limits to our knowledge or understanding.
2. **To promote thinking.** “How can mixing two clear liquids produce a colored liquid?” Thought provoking questions are often asked by a teacher or mentor when the students have been provided with the underlying principles. Proper questioning may help a student generalize from particulars or realize and predict unexpected consequences. Such questions may also form part of the Socratic Method. If, for example, the student makes an assertion regarding a moral or ethical matter, proper questioning can help the student realize the contradiction or underlying assumptions.
3. **To defy or challenge.** The simple question, “Why?” is often asked with an obnoxious tone in response to a command when the questioner well knows the reason. Children learn this questioning technique very early and it does not take a trained ear to recognize it.
4. **To obstruct or delay.** When sticking to the subject could reveal that the student doesn’t understand the material or hasn’t done the assignment the student will often ask some diversion question such as, “Could you tell us about the time you...?”
5. **To show off.** Reporters, politicians, and toady students often ask this type of question, often with long preambles, in which they try to reveal how smart they are. “Isn’t this just a subtle transformation of the brachistochrone problem?”
6. **To interrogate or intimidate.** This type of question is often asked by detectives – “When did you leave the house of the victim?” or by teachers – “Why didn’t you do the assignment?”
7. **To deceive or dissemble.** “Don’t you remember seeing me studying diligently in the library at the time the candy store was robbed?” Or, “Would I do such a thing?”
8. **To provoke.** “Why don’t you shut up and keep your worthless opinions to yourself?”
9. **To vent, accuse, assail or attack, show hostility.** “Why are you so racist (sexist)?”
10. **To beg or implore.** “Won’t you please, please, please forgive me?”

Because good questioning is the key to knowledge and the beginning of wisdom, teachers must encourage students to ask legitimate questions and teach them to formulate good questions. Of course, when questions take up too much class time, as when only one student can't understand the material, the teacher should encourage the student to stay after class for the answer. And because bad questions are often surreptitious devices to disrupt class the good teacher should be able to decipher their nature and intent and, keep them from wasting time and, where appropriate, declare and define them to the student and the class.

As a student I asked so many questions I annoyed a number of my teachers and on a few occasions had the class laugh at me for my presumed stupidity. But I persisted and learned from the answers. One time, in my first semester at MIT in a Fluid Dynamics course I stopped mid question and confessed I couldn't even formulate my question. It caused general laughter. But I got a B and half my silent, mocking, genius MIT classmates wound up with D's or F's. Their laughter meant that they felt as stupid as I did but lacked the courage to own up in class. So, I spent my career encouraging students to ask real questions and praising them for their courage.

Disruptive questions, by contrast, take no courage to ask because they are designed to enlist fellow students as allies and insulate the student from ridicule by their classmates. So, they are often the tool and insignia of cowards, and are easy to recognize. How a teacher should handle them depends on the situation and the student.

In 1990, an African American student in my class repeatedly asked hostile questions that had little to do with the subject and held up the lecture that 90 other students were attending. After about two weeks of tolerating this and trying to give legitimate answers to obviously illegitimate questions and realizing that treating this gratuitously hostile student with kid gloves was counterproductive, I finally said, "I'll answer your question if you answer mine!" Then I asked her, "Why are you publically injecting your racial agendas and resentments into this class on the Atmosphere under the thinly veiled guise of an apparent attempt to learn?" The reaction in the lecture class to my harsh but frank violation of dissembling, diplomatic PC palaver was shock plus acknowledgment of its appropriateness. I could almost hear them collectively suck in air. But calling it as it was it put an abrupt end to the trouble making and everyone benefitted.

*Back to the present!* As the final class of the day began, one of the students asked me if I were the Sub with the eye patch in the fall semester. I answered that I was, and then told the class the brief story

about my eye. I could see that intrigued them and made them receptive to what I might say, so I told them about Bettelheim's book, *The Uses of Enchantment*. “Fairy tales really apply to our lives. You are now preparing to leave your parents and find your own way through life, just like Beauty.” And it resonated! Their attention was riveted. Then I played *La Bella and La Bestia* to an appreciative audience.

The subject alone should carry interest, but people often need a personal touch to develop or be open to an interest. Isn't teaching an elusively awesome art!

That was my last class of the year. It was almost a fairy tale ending.

## Year #1 Postscript

If a large, shiny nugget turned up as you panned for gold, you would surely spot it. Spotting a student nugget that you as a teacher have turned on can be far, far more difficult. You may impact a student's life profoundly, yet not have the slightest hint you have done anything. Sometimes you can see a student's eyes light up, but far more often you will not, especially in a large class and if the student is shy and doesn't want to show you. Furthermore, those eyes may not light up until hours, days, or even years after the spark you planted. Your impact may be subliminal. Sometimes you will help the student change but the student will never make the link, just as if you hum a tune you just heard but didn't realize you had.

As a regular teacher you have a finite chance of recognizing that you have had an impact on a student because you see that student repeatedly for at least a semester. In a few cases the student may return later to thank you. But as a Sub, you seldom see a student more than once. If you encounter the same class months later, few students will remember and fewer may comment. Most people are silent, most that are not silent are not introspective, and most that are vocal and introspective are not likely to let you know about any possible impact you have had on them.

Knowing this, I sub in the hope to open some eyes and have some positive impact. My reward is if that hope is fulfilled. Having a chance of ever seeing that reward is another story.

My most striking story of not realizing that I had turned on a student took place when I was a young professor. The lecture class had 120 students. Right after lecture ended one day I encountered a gorgeous young woman student in the aisle. I said something flirtatious and she stonewalled me. "That's cool" I said to myself. I often flirted but never came on to students. "What, never?" "No, never!" [But I was tempted.] So, the incident passed without incident. The semester ended and we went our separate ways.

I did not see or think about her for the next ten years. Then, she made an appointment to see me. I did not remember who she was until we met. She was unhappy in her job. She told me that she loved and was so inspired by my class that she was thinking about becoming a meteorologist. I was stunned. I mentioned the flirting incident. She hadn't recognized it as flirting. All she had felt was extreme shyness and honor that a 'great' professor had deigned to say anything to her.

You never really know what impact you have had on anyone. "What never?" "Well, Hardly Ever!"

## **Year #2: Day #18: Great Teachers: Drilling and Surprise**

On this, the first day of my second academic year as a Sub (Tuesday 27 August 2013), I came to school with a question that had been stewing in my mind for years. "What makes a teacher great?" This day helped me draw closer to a satisfactory answer.

For the 3<sup>rd</sup> time the call came from the Calculus teacher at Hillsdale. I started too late to walk so I rode my bike, risking my life in the insane rush hour and school traffic.

I arrived to an enlarged, tough, but auspicious schedule. There was a shortage of Subs, so as per the contract, I was awarded an extra class – Physics, 3<sup>rd</sup> period. Using Calculus, I quickly derived the standard formulas of motion for constant acceleration from Newton's Equations of Motion. It was over most of their heads, but I briefly stopped their grumbling by informing them that I had just shown them what they would cover over the next 6 weeks. In retrospect, I should have prefaced the derivations by writing on the blackboard, "Calculus will set you free", and then repeated it out loud as if to say, "The truth will set you free." Oh well!

Then I noticed a floor spring scale, a perfect device to illustrate the physics concept of force. I placed my hands on opposite sides of a scale, squeezed it with all my might and generated 125 pounds of force. I had played that game over 40 years before. At that time I generated 140 pounds of force. Getting old isn't fun. At the time, my friend, Ronnie Blomberg, an extraordinary athlete who played baseball for the NY Yankees, squeezed 210 pounds.

Then I got the students to squeeze the scale. Almost all the boys and a few of the girls were interested and it got several interesting reactions. The best kid in the class did 170 pounds. A few girls squeezed with force but some couldn't even generate 40 pounds and winced with delighted embarrassment when I called them ultimate Wimps.

Several kids had been in the Math class earlier that day. As they left the room I asked one which class I had done better in – Math or Physics. She said, Math, and she was right. I hadn't prepped for Physics. A little prep is necessary even if you know the subject pretty well.

The math teacher had three AP Calculus classes and two classes of 'Integrated' Math. 'Integrated?' Not again, please! I prayed that I was wrong but greatly feared, different school, different subject, but same euphemism for inferior. Recall Day #8, where 'Integrated' Science was Aragon High School Administrators' lingo for slow Science. In the few minutes before the students piled into class I surveyed the attendance lists. The 'Integrated' Math classes were filled with juniors and seniors

(11<sup>th</sup> and 12<sup>th</sup> year students). Then I looked at the text, which began with Elementary Algebra. American students normally take Elementary Algebra in 9<sup>th</sup> grade if they are not good in math and 8<sup>th</sup> grade or earlier if they are. I had the sneaking suspicion, soon confirmed, that most of the kids had taken this math course at least once before.

My worries about class behavior eased when the students entered animated but in line. The chairs and desks were arranged in groups of four – the assignment for each class was to solve a problem set in groups. I designed my introduction to lead naturally to the essay I wanted each student to write about teaching excellence. Then I gave each class a short lecture.

Since it was near the beginning of the year the AP Calculus class was still working on the important preliminary concepts of continuity and limits. I decided to give them an overview similar to what I gave to the Pre-Calculus class on Day #9, but with more of the formal material given in Calculus classes.

"Right now your teacher is giving you concepts that prepare you for Calculus. I want to go ahead a bit and give you a hint of what Calculus covers. Calculus might be called the math of curves. It deals with two primary issues.

The first issue that Calculus deals with is **Rates of change = Derivatives**. If you know your interest rate, you can predict how fast your money is growing.

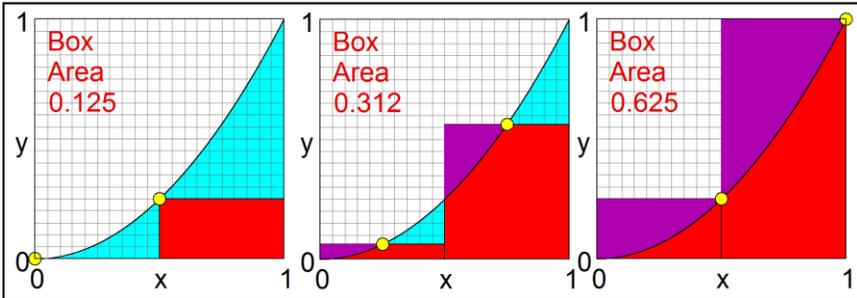
The second issue that Calculus deals with is **Totals or Areas = Integrals**. If you know how much money you start with and know the interest rate you can determine your total money at any future time. So, Calculus is the mathematics used to make predictions. That includes weather forecasts, my specialty.

I will give you a hint of how Calculus calculates areas. But, let's start with a few simple questions. The square I drew on the board has Length,  $x = 1$  and Height,  $y = 1$ . What is its area?... Right! The formula is Length or base,  $b$  times Height,  $h$  so the area,  $b \times h = 1$ . That problem is so easy you did it as soon as you learned to multiply in the 3<sup>rd</sup> grade or so. Next, I split the square diagonally. What is the area of the resulting triangle?... Yes,  $= \frac{1}{2}$ . The two triangles are equal, so each is half the square. And you know that the area of a triangle is  $\frac{1}{2}b \times h$ .

You don't need Calculus for these baby problems. But here is a tougher question. What is the area under the curve  $y = x^2$ ? First of all, what is that equation called? Right, a parabola! Finding the area under or inside curves is a main job and triumph of Calculus.

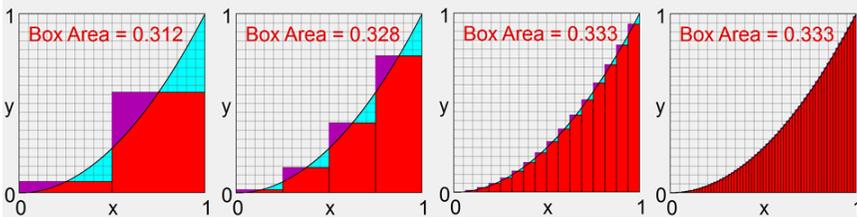
Newton got the idea, but a mathematician named Riemann may have been the first to put it in a nice graph form (Figure 9). In all frames, we

will compare the area of the rectangles, which are red below and purple above the parabola to the area under the parabola. Start by dividing the interval into a left and right half and draw one rectangle in each half whose tops touch the parabola at some point. Three touching points (the yellow circles) make sense – 1: the left side (left panel), 2: the center (center panel), or 3: the right side (right panel).



**Fig. 9.** Using rectangles to estimate the area under the parabola when it coincides with the yellow dots at left, center, or right side of the tops. The center point gives the best match.

In the left panel we only see one rectangle because the height of the left rectangle is zero. In the left panel the rectangles have a much smaller total area than the parabola. (The turquoise area is the deficit.) In the right panel, the two rectangles have a much larger total area than the parabola. (The purple area is the excess.) In the center panel, the excess purple area almost balances the turquoise deficit area so that the total area of the rectangles is pretty close to the area of the parabola. So Riemann made the best choice – the center panel.



**Fig. 10.** Improving accuracy of approximation to the parabola's area by increasing the number of rectangles from 2 to 4 to 16 to 64. For 16 rectangles  $A \approx 0.33301$ ; for 64,  $A \approx 0.33331$

Riemann then took the next step. He divided the interval into an increasing number of thinner rectangles (Figure 10). You can see that

this leads to closer and closer estimates of the area. By the time there are 64 rectangles, you can scarcely see the difference between the parabola and the rectangles. Ultimately, using mathematical induction and taking limits as you are now doing, would prove that the area under  $y = x^2$  is  $x^3/3$ . This area is called its Integral!

"Well, that's a start. You'll spend much of the year in Calculus doing derivatives and integrals."

During this presentation, several students' eyes opened wide. They excitedly asked a few on-target questions such as, "How high is each rectangle?" They were hooked!

And that brings me back to the grand question...

### **So, What Does Make a Great Teacher?**

I address this question in four steps. 1: I describe a scene from a film that involved teaching or mentoring. 2: I recall my great teachers and tell why I feel they were great. 3: I compile and analyze what the students wrote in their surveys. 4: After much reflection I arrive at a synthesis.

No, the film is not the *Blackboard Jungle* or *To Sir with Love*, or some other tendentious movie where an aspiring engineer, forced to take a lowly teaching job in a slum while waiting for a real job offer, winds up converting all but one incurably evil student (who dies or disappears) and then decides to stay on for the rest of his life as a teacher. No, the scene I am thinking of comes from the 1984 film, *The Karate Kid*.

After being beaten to a pulp, the Kid is rescued by Mr. Inagi, the apartment's quiet, unassuming handyman. The Kid recognizes Mr. Inagi as a karate master and comes to him to learn. Mr. Inagi insists the Kid swear to obey all his orders explicitly without question. Mr. Inagi then assigns the Kid a series of endlessly onerous, seemingly mindless and irrelevant tasks. First, wax Mr. Inagi's large collection of antique cars. The motions are explicit. With giant pads, wax on with the right hand using a clockwise sweeping motion. Then, wax off with the left hand using a counterclockwise motion, all the time breathing in and out in rhythm. The next day it's paint the fence, with specific up and down motions.

After several more full days of these mindless, exhausting exercises the Karate Kid rebels. When Mr. Inagi attacks the kid, calling off the motions of the assignments, the astounded boy sees how much karate he had learned and committed to heart step by step. That was the approach I crawled my way towards as a swim instructor and the same approach that was dramatized so superbly about learning to dance in the 1996 *Japanese* film, *Shall We Dance?*

A neuropsychologist used a curious game, speed stacking of cups into pyramids, to illustrate the value of the Karate Kid's training. 'Cup Boy', an 8 or 9 year old master, can stack and dismantle cup pyramids so rapidly the untrained eye can't follow. The neuropsychologist, who was new to the game, competed with Cup Boy while each was connected to an electroencephalogram. The boy's brain waves scarcely changed as he raced through the task while the brain waves of the much slower, struggling neuropsychologist were off the chart. Far better it would be if Cup Boy had chosen to master some musical instrument instead of the useless practice of stacking cups, but that is another matter. What does matter is that through incessant practice, Cup Boy had rewired his own brain to create an integrated circuit for cup stacking that led to speed, ease, and yes, genius. So too did the Karate Kid.

So, surely one basic characteristic of a great teacher is someone who 1: breaks a subject down into its essential elements, 2: gets the students to practice the elements relentlessly until they become automatic, 3: shows the student how to combine the elements, and 4: gets the students to practice the combinations relentlessly to ultimately attain mastery of the entire subject. Is the master teacher a taskmaster? You bet your task!

Consider my daughter, Elise's 8<sup>th</sup> grade algebra teacher. Mr. Haas covered his classroom walls with an infinite, mind numbing collage of photos of professional athletes. He was clearly a nut but was efficient and exacting. He drilled his students day after day, as if they were in a year-long boot camp. And the results showed it. At the end of the year the regional high school tested all students from the feeder intermediate schools to determine who had learned algebra well enough to advance to geometry. Every one of Mr. Haas's 23 students passed the test. In the neighboring, equally upscale town, only 3 of 20 students passed. This happened year after year.

It is likely that a good number of Mr. Haas's students resented him as a drill sergeant. Elise did for a few weeks. Some kids may never have recognized him as a master teacher. But when they got to high school and found out that while all of them had passed the standard algebra test, almost none of the kids from the equally upscale town had, many must have realized that something miraculous had occurred in Mr. Haas's class and that they had studied under a master.

Jaime Escalante was made world famous by the film, *Stand and Deliver*. Jaime came to Garfield High School as an experienced Math teacher from Bolivia. He was a force of nature, convinced that math flowed in the blood of his low-performing Hispanic students. For a few years he could not get to first base because of hostile administrators, who almost fired him. But once he was freed by a new, cooperative and

tough principal, Henry Gradillas, Jaime and Ben Jiménez (a math teacher Jaime recruited but who was not portrayed in the film) began to perform miracles. In effect, they instilled a wartime mentality in large numbers of the low-performing, ‘inferior’ Garfield students and garnered them into a juggernaut. The film did a fine job of portraying how much hard, relentless work and discipline was involved by teacher and students even though grossly understating it and the long, necessary time span of several years just to get to Calculus. And the vital role played by Principal Gradillas, which was not stressed enough in the film, cannot be understated. Once Gradillas left the school to complete his Ph. D. the dream that was Camelot fell apart.

I realized by reflecting on the step-by-step discipline these master teachers mandated from their students, that the subjects I have some skill in, but feel incapable of teaching are those for which I haven’t isolated the elements. Every great recipe must start with the ingredients. Crucial of course is the recognition that each field has its elements and structure.

Even when the elements of a subject are identified, there often remains an initial hurdle to surmount before you can make a start or progress. The skeleton or framework provides the springboard to surmount the hurdle. But sustained and disciplined effort, either mental or physical, plus inspiration are always needed, somewhat like starting a lawnmower requires a great pull before the engine takes over.

When my son, Evan was about to give up the piano because a new teacher gave him ridiculous pieces like, “Here we go, in a row, to a birthday party”, I played Bach’s *Minuet* for him. I am sure he had heard me play that piece many times before, but only subliminally. This time, he was ready. He was immediately entranced and has since become a fine pianist. Without that key push from Bach he may never have played. A great (or lucky) teacher is one who provides the student with that key to the springboard and the inspiration to surmount the barriers.

So, who have been my great teachers? How did they inspire? Did they instill the elements? Did they provide a key? Did they bring about a synthesis? And, what else did they do?

Grade school was a vacuum. Sorry! Most did their jobs but it seemed to me that any time I learned something on my own I was way ahead not only of many of my classmates, but of the teacher as well. Junior High School brought teachers with far greater knowledge in their fields. My first great teacher, Mr. Baxter, my home room teacher, taught us Social Studies in 7<sup>th</sup> grade and Science in 9<sup>th</sup> Grade. I only remember two items in 7<sup>th</sup> grade. Mr. Baxter confessed that he had tried to be an engineer but had failed. He then tried to be a lawyer but failed again. I guess that his failures humanized him to me. I felt that as a teacher he was no failure

and that I could be a success. Second, one hot day late in spring Mr. Baxter took off his sports jacket and instead of a well formed athlete was a sad, little, pot-bellied body. Disillusioning, but I didn't hold it against his teaching. His sense of idealism, brewed with or born of his failures, frustrations, and limitations was likely the essence of Mr. Baxter's greatness for me. But he also illuminated me by surprise. In 9<sup>th</sup> grade science, when he introduced the principles of pulleys, levers, and the Pythagorean Theorem, my eyes were opened. It was as if Mr. Baxter, in his seemingly haphazard but inspirational way, found the key that released ideas that had been ready to burst out of me.

All my other great teachers have been strict disciplinarians, not so much of behavior, as in their fields. They have been the Mr. Inagis, breaking down the subject into its elements, forcing me to drill toward mastery, and who possessed that strange, fanatical zeal in their subject. I have already mentioned my Spanish teacher, Mr. Leventer, and his daily quizzes that I later used as a model in some of my classes. Oddly, I remember only one lesson. Mr. Leventer was rhapsodizing on behalf of the value of knowing Spanish. "Imagine", he told us, "you can speak Spanish and a poor Puerto Rican comes into your law office needing help and you say..." I, the idealist already tainted by cynicism, deeply admired his idealism but interjected cynically, "Get out!" Mr. Leventer turned and glared at me, and I met his eyes. What I meant by this crass interruption was that most of my mostly materialistic classmates, would, in fact have unceremoniously thrown the poor Puerto Rican out of their plush offices, whether or not they knew Spanish. I am almost positive that Mr. Leventer understood. As I already mentioned, one of my greatest mistakes in education was not taking Mr. Leventer for AP Spanish the next year.

Next was Professor Mark Zemansky in freshman physics. Early in the year I showed unusual insight in problems that involved proportions. I got answers without going through the usual procedures. It both impressed and annoyed Professor Zemansky. On the first test he told me I would get no credit for simply getting the answer – I had to do the problems the right way. So I got a 43%. That ended my rebellion. I learned the proper methods he taught so well.

Then there was Professor Jesse Douglas (who had won the first Fields Medal) in Advanced Calculus. With my poor discipline, I had bumbled badly through Calculus, Differential Equations, and Applied Advanced Calculus. I took Advanced Calculus despite warnings that since I had screwed up earlier I would surely fail. But I knew I needed a better foundation. I was ready and could not have had a better master. At every

sentence I was one sentence ahead of Professor Douglas but only one because I could not phrase things in the leading way that he did.

I have mentioned Dahlia in Israel in Hebrew. Being a student under Dahlia helped make me a better teacher. When you are in intimate contact with the difficulty of learning a new subject you can better identify and sympathize with your students as they struggle to learn material you have become easy with – and perhaps too easy. I audited a course in physical chemistry taught by my colleague, Jack Morrow, an excellent lecturer, and once asked a basic question that briefly stumped him. He confessed that in teaching the same thing for many years he had become too facile and had forgotten the origin or some critical link in that topic.

To this list I add three lecturers that took my breath away and had lasting impact on me and my teaching. In the summer of 1976 I was enrolled in a Post Doctoral Program on Weather Forecasting. My former professor of Statistical Weather Forecasting, Edward Lorenz gave a lecture on Predictability, soon to be known as Chaos Theory, which he founded. Lorenz had been an excellent professor, making statistics and linear algebra seem disarmingly simple. When we asked him to teach Predictability, he had humbly refused. But on this occasion he gave the essence of Chaos theory in such a simple, compelling lecture, I was blown away. I blatantly plagiarized some of his talk when I lectured on predictability to my students.

Second, in 1984, at a conference on Atmospheric Optics (rainbows, halos, mirages, and sunsets), Robert Greenler gave a talk that included stunning, unforgettable demonstrations. One in particular I can still see. Using a slide projector, he shone a small circle of light through a tank of water and on the screen in front of the room. Slowly he added skim milk to the water. As the milky water turned a bluish gray the circle turned orange. This, Greenler claimed, operates on the same principle that turns the sun orange when it rests on the horizon. Then, to prove his claim, Greenler simultaneously turned off Projector #1 and turned on Projector #2. Projector #2 had a photographic slide of a sunset, with the image of the sun in exactly the same place and with exactly the same size, color, and brightness as the light beam penetrating the milky water. Again, I plagiarized all I could when I taught that subject to my classes.

Third, in 1990, Alan Hildebrand gave a talk at the New York Academy of Sciences on the Chicxulub Impact responsible for ending the Mesozoic Era and killing the dinosaurs 66 million years ago. At the time it was still a contentious issue (the impact site had just been discovered) but Hildebrand proceeded to cover every aspect of the impact and its consequences and cogently dismantle objections to the

theory. I left the lecture exhilarated and proud to be a scientist. And this lecture too mysteriously resurfaced in my courses. As satirist Tom Lehrer sang,

Let no one else's work evade your eyes!  
Remember why the good Lord made your eyes.  
So don't shade your eyes!  
But plagiarize, plagiarize!

In these lectures (as with Mr. Baxter's lessons on Physics), a central component of their lasting impact on me – a surprise I was ready for – was a result of serendipity. I surely attended many other outstanding lectures that I found less revolutionary, exciting, and memorable simply because they covered material I was either more familiar with or totally unprepared for. In Real Estate, it's Location, Location, Location! In teaching it may well be Timing, Timing, Timing. And this element of surprise is precisely where a Sub can by accidental design become a miracle worker!

On the matter of timing, I should add my college freshman English Professor, Leo Hamalian. He came at exactly the right time of my life; he helped open my eyes when they were ready to open. But one day walking out of class a bright classmate told me that she thought he was mediocre. I was shocked but immediately thought of Lincoln's famous adage, "You can fool all the people some of the time..." It made me realize that no one is a great professor to everyone.

Is being an active scholar an essential component of a great teacher? I think so but the importance of the teacher's level of scholarship depends on the student's level. Surely, at any level, actively maintaining and displaying enthusiasm in the field or in learning is essential. Yet sometimes, as is portrayed in movies such as *Educating Rita*, the roles reverse and a driven, enthusiastic student revives the enthusiasm of a teacher who has become indifferent or moribund.

For a long time I fancied myself to be a great teacher. I was extremely confident when I walked into a class, and my students could see it. But over the years some significant questions and doubts bubbled up. If I were so great then why didn't my students learn better? If I were so great then why didn't students flock to my courses at City College?

So, why didn't students flock to my courses? Open Admissions was an enormous factor! I was consoled by one encounter at CCNY and by my popularity during my Sabbatical year at UCLA. One morning in the hall of CCNY's Science Building, a student approached me and asked if I were Professor Gedzelman. When I nodded, he said, "I heard you were

great but I'm not going to take your course because I also heard you are a real tough grader and I don't want to risk my GPA." I took that encounter as generic proof of my teaching greatness, and that students would have stampeded into my classes if I were an easy grader.

My vaunted self-assessment was reinforced by the student response during my Sabbatical year at UCLA, where students averaged so much higher than CCNY students and where droves of them did flock into my introductory lecture classes on the Atmosphere. In the last quarter, the hall of 360 filled to capacity and more than 100 hopefuls had to be turned away. The semester I returned to Open Admissions CCNY, its inferior, moribund students averaged only 37%. No wonder that they avoided me like the Plague. Even a tough grading God could not have reached them.

As I grew older more doubts about my presumed stellar teaching qualities crept in. I certainly was not the caliber of scientist that my Professors in Graduate School at MIT had been. They were founders in the field. I felt that my knowledge was limited and I had not expanded its base as I should have. My research was mediocre; I failed to follow up on any hints I had of important new avenues of research.

The greatest blow to my professional ego came in 1995, when the Meteorology Program at CCNY was terminated and merged into an Earth Systems Science Program during one of New York's recurring periods of 'fiscal exigency'. I barely kept my job. It was clear that the planets did not revolve around me. So, time and reality reduced this "Great" Professor to one who was happy to survive.

To do so I had to learn enough geology to teach it. I sat in on my geology colleagues' classes and lectures. "Wow!" thought I. "[They are pretty good teachers. In some ways, many of them are better than I am.](#)" I plagiarized from them too.

Shortly before my last semester as a Professor at CCNY, I purchased an audio recorder intending to record my lectures and turn them into a book. I made detailed post mortem notes of each lecture. That effort, which involved introspection and critiquing, further diminished my self assessment as a great teacher. I could see time and again and in more ways than I might like to admit where I had fallen short.

In taped interviews and in a compilation of essays, *The Pleasure of Finding Things Out*, the maverick Nobel Laureate in Physics, Richard Feynman concluded that teaching excellence is something elusive. Things that worked beautifully in one class failed dismally in another; things that turned on one person failed for another. Feynman's son loved his educational games; his daughter was indifferent to them and only wanted him to reread stories from books. So, unlike in Quantum Electrodynamics, where Feynman helped to pin down the fine structure

constant to many significant figures, he couldn't find any constant for teaching excellence that he could pin down even to one significant figure, given human variations. He therefore urged a somewhat random approach to teaching that might grab one student today and another tomorrow. I sadly joined his camp, recalling the good and bad classes I had taught. I concluded finally that I had usually, but not always, been a good teacher, and possibly great on a few rare occasions.

Two of my friends in graduate school had gone to Cal Tech as undergraduates, and had Feynman for Freshman Physics. They agreed that he was a fine lecturer, with panache and a great sense of humor and what appeared to be astounding insights, although they complained there was little relation between the lectures, the homework sets, and the tests.

Another trait of outstanding teachers is that they work super overtime. Jaime Escalante was one example. Randall McCutcheon and Tommie Lindsey started and ran a debate team, trained the kids and took them to competitions, where many became debate champions. Their book, *It Doesn't Take a Genius* includes high praise about their dedication and impact from former students. For many years, Rafe Esquith (*Teach Like Your Hair is on Fire*) worked 12+ hour days, six days a year and was selected as 1992 Teacher of the Year. He had his 5<sup>th</sup> grade kids work long days too, reading and performing Shakespeare plays and giving musical performances. Widely loved and admired, he helped inspire many of his mostly poor pupils on the road to successful lives, and many kept contact with him over the years. (Sadly, he was recently fired for a stray remark with sexual overtones.)

I obtained some more insight about the nature of teaching excellence from another direction. Nine months into my retirement from CCNY I enrolled in a Memoir writing class. The class has been a great joy, filling many hours in this retiree's life. The teacher, Katherine Lieban, is gracious, kindly, and lenient. Students – almost all senior citizens – come back semester after semester. They write Memoirs and anything else they want – stories, poems, and essays. I too have become a repeater. I never sub on the day of Memoir class.

Every week, Katherine brings in a prompt or theme to write about for the next week. One recent theme was, "Why do I write?" Despite having written stories and poems before, during and after my career, I had no ready answer. Why *do* I write?

As I sat without a hint of my motives (other than ego and the desire for praise and attention) it suddenly came to me that no one thinks to ask the same question about why we talk. That's one key. Writing is a form of considered talking that takes more discipline. [A few years after this I was pleased to read in *Teacher Man* that Frank McCourt said the same

thing to his students.] So our motives for both writing and talking will have much in common.

I framed my essay with a short list of motives, and then interlaced the writing with whatever insights I came up with as I wrote, and was content. Here is my list in no specific order.

### **Motives for Writing**

1. To improve writing skills.
2. To communicate and win friends.
3. To win fame and fortune, recognition, and approval.
4. To solve or resolve problems – clarify thinking.
5. To make a record and improve memory.
6. To say it better - get revenge for a time you lacked the right retort.
7. To create, of course.

Similarly, I could start to answer the question of what makes a great (or rotten) teacher by creating a list of qualities. But it did not occur to me until a few days after my appearance in class that a key to the elusive answer might only come by asking a different question. In fact, asking an alternative question may be a general technique for getting elusive answers to difficult or impossible questions.

First though, let's get back to class. I barely had time to glance at the attendance sheets before the students started piling in for the first period. I decided to introduce myself in such a way that it would lead naturally to ask them to write an essay on their best teacher. So here goes.

“Good morning. Obviously, Mr. L. is out today. I'm your Sub. Let me tell you something about myself. This is my second year subbing. I subbed for Mr. L two times last year. Before that, I was a Professor of Meteorology for 42 years at the City College of New York. Do you know what Meteorology is? [Someone did.] During that time I had 3 sabbatical years at different Universities. A sabbatical, like the Sabbath, occurs every seven years and Professors have the chance to use it to travel and do research elsewhere. My first sabbatical was at Tel Aviv University in Tel Aviv, Israel. My second was south of here in California at UCLA, in Los Angeles. I really wanted to become a full time Professor there but didn't succeed. My last sabbatical I spent at the University of Granada in Granada, Spain.

My career had a lot of research and writing in it – both books and scientific research articles. When I subbed last year in Mr. L's class I noticed how huge and bloated the math texts were. I couldn't even read the Geometry text! [Some kids laughed at this!] So I decided to write a Calculus book that covers the curriculum, and I did it in 190 pages

instead of 1100 pages. It should be in print later this year. I call it *Calculus: Your Royal Road to Genius* because it does take genius to master Calculus, and you geniuses will master it.

I am also writing a book on *you* and my life as a Sub. Perhaps because I come from New York City I call it *Sub Ways*. [That got a few laughs.] But now I need your help. [They saw that I meant it.] After 42 years of teaching I still do not know exactly what it is that makes a great teacher. I certainly know some of the ingredients for a great teacher. But I can't bring a complete story to life. So, I am asking you to help me.

Get out a piece of paper, print your last name first, then your first, and write a paragraph about your best teacher and, most important, what made them the best. Include the subject and the year." As I was assigning and defining the survey to the first class, I realized that some might have an easier time describing their worst teacher, so I said,

"Come to think of it, if you can't think of your best teacher, write about your worst teacher, but no Subs included. You can name them or leave the name out. I will not show this to anyone here – not your teacher or your principal, etc. If I like what you have written I may use it but I won't use your name because of possible law suits."

No sooner did I say this than several students said they wanted their name to be used. So I told them to add a star beside their names if they wanted me to mention their names. There were a lot of stars!

Of course, I would never use any of their names. This would violate one of the cardinal rules of the Education Empire that by doing so I would expose them to grave danger. Strangely, the students did not feel at all at risk.

I gave the assignment to 4 of the 6 classes, and 109 students responded. Their answers were generally frank and sometimes highly personal – even poignant and heart wrenching. What struck me was the contrast between the apparently casual manner in which the students presented themselves as they sat in front of me that revealed nothing in particular of their inner lives, and the revelations in which they opened their hearts on paper. Of course, that is true of us all. Many people are closed books until they write their books.

Table 3 lists the qualities students felt a great teacher possesses (**Pos**) and a poor teacher lacks (**Neg**). I was surprised that so few students mentioned knowledge and none mentioned intelligence or eloquence. Perhaps the students assume it goes without saying that a great teacher must be knowledgeable. Perhaps they didn't think of many of their teachers as either brilliant or experts or masters in the field. I think that undergraduates and especially, Masters and Ph. D. students consider

knowledge, expertise, scholarship and/or academic brilliance much more important as criteria of a great Professor.

<b>Quality or Characteristic</b>	<b>Pos</b>	<b>Neg</b>
Easy (Standards)	3	1
Encouraged Thinking rather than Rote	8	1
Explained well or simply	16	3
Fair and Unbiased	4	5
Flexible regarding Rules and Discipline	6	6
Friendly	12	4
Fun, Enjoyable	16	0
Helpful	27	2
Humorous or Funny	21	4
Inspired, Charismatic, Energetic, Happy	17	2
Knowledgable	9	4
Made the Material Seem Relevant	16	1
Mentor	8	0
Organized	9	10
Strict re discipline or Expectations	12	9
Sympathetic	27	15
Technically Savvy	5	1
Well Prepared	4	3

**Table 3. Characteristics of the best or worst teacher and number of positive and negative responses for each characteristic.**

Somewhat later, I asked a number of teachers what makes a teacher a master teacher. This is their list of necessary (but not sufficient) qualities.

1. Love and know the subject (and learning).
2. Maintain discipline but do not be a martinet.
3. Love the kids.
4. Be a guide or mentor.
5. Be sensitive to differences between kids.

The brief list is similar to the qualities chosen by the students with the notable exception that the teachers stressed love and knowledge of the

subject. The Dalai Lama's even shorter list also includes academic excellence.

1. Academic excellence
2. Moral integrity
3. Kindness

For, how can you be a great teacher if you don't love learning as well as the act of learning, and perhaps, the people who learn?

Regarding kindness, the Dalai Lama is quite specific about what he means by it. He does not mean giving good grades for poor performance. And great teachers may indeed be tough if their intentions are good – namely, for the good and advancement of the student. Some students require tough treatment while others require gentleness, and it is the teacher's job (and skill) to know which to use and when.

The students mentioned personal qualities more often and with greater intensity than scholarly qualities. They acknowledged knowledge as a positive trait, but only if the teacher did not lord it over them and treated them with honor. Students highly valued teachers who appeared enthusiastic, happy, energetic, and made the class funny in a way that related to the subject. Thus, a great teacher must have a dramatic flair, i. e., be the opposite of a pedagogue. Students were thankful for teachers who went out of their way to be helpful. And indeed, many of the teachers do go more than the extra mile. Some seem to be so dedicated to their students' lives I can't see how they have any time for their own.

The most frequently mentioned criterion was sympathy. Students felt it important that the teacher respected them as people. Indeed, a kiss of death for a teacher is to appear unsympathetic or demeaning to students. When being strict was accompanied by a degree of flexibility it was respected, but another kiss of death was when the teacher was a martinet and yelled at the class or picked on students unfairly. That was always counterproductive and aroused some students to active spite or hostility (recall my disastrous Climate class).

My brother, Robert's sympathy for the downtrodden may have lit the key spark that changed one of his student's lives. The boy was a bright but troublesome, hostile, misguided student. As a Black he raged against the White world. My brother took him aside one day and said, "You want to get your revenge? Become a lawyer. Then you can f\_\_\_ the White World." My brother could see that it registered. From that point, the boy became a model student. He ultimately graduated from law school, and came back to thank my brother for that critical impetus.

Preparation and organization were not mentioned often as virtues, perhaps because they are assumed virtues of great teachers (a little chaos is often essential) but when these qualities were absent they were seen as strong negatives. A Spanish teacher who was a mid-year replacement, was savaged by a large number of the students as their worst teacher by far, because all she did was talk about herself, never taught, and then gave tests on material she didn't cover. The school's administrators must surely have been aware of her shortcomings and were simply unable to find a competent replacement. That is odd, considering how many Spanish speaking people live nearby. But that is a consequence of the Education Empire's licensing policy.

Table 4 shows links between the students' math level and their choice and opinions of best or worst teachers. There were three distinct math levels. The students in the two AP Calc classes were at the top. The students from the Physics class who answered the survey had not yet reached Calculus but had passed elementary algebra. The Integrated Math students were clearly at the bottom of the math barrel.

<b>Class</b>	<b># Reasons</b>	<b>% Best</b>	<b>% &lt; High School</b>
AP Calc Pd 1	2.43	78.3	21.7
AP Calc Pd 2	3.03	83.3	11.8
Phys Pd 3	2.31	55.9	21.2
Int Math Pd 5	1.67	60.7	34.8

**Table 4. Responses by class. Avg # of reasons per choice, % of choices for the Best teacher and % of chosen teachers prior to (<) High School.**

Students in Calculus offered significantly more reasons for their choices of good and bad teachers than students in Integrated Math. They also were much more likely than the Physics or Integrated Math students to choose their best rather than their worst teachers. Assuming a binomial distribution for the two categories (best or worst), the probability was 3/10,000 for the Physics class and 9/2000 for the Integrated Math class that these disparities occurred by chance.

There was also a profound *qualitative* difference between the Calculus students and the Integrated Math students. The students in the Calculus classes emphasized pedagogical factors in their evaluations, even when they indicated personality characteristics that they loved or despised in their teachers. But for the Physics and especially Integrated Math Students, the teacher's personal touch was much more important.

Here are two extreme examples. In the first, a sympathetic teacher had a deep and lasting positive impact on the student.

"My best teacher was Ms. L. for 3<sup>rd</sup> and 4<sup>th</sup> grade. I was new to the school in 3<sup>rd</sup> grade. On my first day I was quiet and shunned myself into the farthest seat in the back of the class. Nobody talked to me, but when Ms. L. saw me for the first time, her eyes told me that everything was going to be fine. She introduced me, asked me questions, tried to really get to know me. And she looked like she was actually interested in what I had to say. She was intrigued by my pointless facts about who I was, because she knew I wasn't expecting much...She wanted me to expect better. As the months passed, I got more comfortable at the school, had a few friends to hang out with at recess and lunch, and was doing well in my classes. Ms. L. was still interested in me. She would check in with me, to see how school or my home life was. She would sometimes hover over my shoulder, reading my work, and I'd look up and see her smiling at me. Ms. L. made me feel important and I believed her. I came to the conclusion that I did matter."

I assume that this sweet young lady is still troubled by a weak self image, and that it began with a poor or inadequate home life. The troubled students were more likely to view the teacher as a replacement for the parent, and this is indicated by the fact that the students in the Integrated Math class were most likely to choose a Primary or Middle School teacher.

The next quote represents the opposite situation of a terrible reaction to a bad or angry teacher – a case of abominable interpersonal chemistry.

"I hate him. And he hated me. He sucks at teaching. We had many arguments and he gave up on me. So I just chilled in the back, slept, or ate in that class. He was a terrible teacher because he didn't try to understand his students and was a dictator in class. He would get mad when something didn't go how he wanted, so I would piss him off on purpose."

This is a good quote to keep in mind if a student, or anyone, ever shows hostility. It helps if we all know that we all know the game. Indeed, a few other students confessed similar deliberately hostile or disruptive behavior when they encountered a teacher that they felt was mean to them or picked on them. Most troubled or problem students do

not resent being disciplined if it is done without hostility or bias (as the Dalai Lama pointed out).

It also struck me that this student's printing sloped distinctly backwards or up to the left. According to graphologists the backward slope [for right-handed people] is the classic mark of a closed personality. You won't get anything out of this student. I decided to check the slope of all the surveys. In the Integrated Math class, 18 of 25 students printed with a backward slope that was, in many cases, pronounced. In the two Calculus Classes only 11 of 52 students printed with a backward slope; most of their printing was upright. The difference between these two groups is statistically significant at the 99.9999993% level. By the way, all but 2 students printed their responses, and in all classes many did so with impressive neatness. I assume that with the computer and keyboard, cursive writing has gone the way of the dinosaurs.

Here is a touching quote from a troubled student in the Integrated Math class who is falling further and further behind in school and is clearly in the wrong place.

"I don't like or hate any of my teachers but I do hate how they teach. I never seem to learn anything in class. I feel like sitting in a chair for 8 hours won't help anything I learn with experience. In school they teach you the same subjects [over again], it's just that they get harder and harder every year. We should have to learn those subjects but we should also be able to learn different classes, more about life. Because I'm sure anyone [sic. no one] is going to a store one day and say, "can I have  $x$  amount this?"

In much of the United States the vocational diploma, now called CTE (Career and Technical Education) was phased out over the past 50 years and has only recently been undergoing a bit of cosmetic resuscitation (i. e., lip service). The Education Empire has embraced and fostered the conventional ideology that everyone deserves a chance at success in life and that the sole path to success flows through the High School Academic Diploma and on to a Bachelors Degree in a 4 (or more) year College. It was nice to hear New York City's Mayor, Michael Bloomberg say in his 2008 re-Inaugural Address,

"This year, we're going to begin dramatically transforming how high school students prepare for technical careers in a number of growing fields. Traditionally, such career and technical education

has been seen as an educational dead-end. We're going to change that. College isn't for everyone, but education is."

Never mind that Bloomberg's Assistants (cronies) fudged or buried education statistics whenever there was a hint that unfriendly reality might peer through. (Charter schools get a 5-year pass free of statistical evaluation.) His words make sense. The young lady who wrote the poignant paragraph above and millions more like her every year in the United States will always find algebra to be an incomprehensible foreign language. Teach them, if you can, to calculate the interest they must pay on a mortgage and let it go at that. Find the subjects that they can excel in or at least perform with competence. They will feel better about themselves, benefit from the change and in the end, the society will benefit as well.

A 2004 study by the Mathematica Policy Research (MPR) group included a statistical analysis showing that taking vocational courses had no impact on high school graduation rates. Earlier studies had shown a positive correlation between taking vocational courses and the HS graduation rate. We must conclude that any effect on graduation rates is small. But if students take courses that match their abilities, talents, or proclivities, the impact has to be positive, even if it doesn't show in graduation rates. The MPR group pointed out that current hypotheses relate High School Dropout rate to much earlier childhood experiences. That makes sense.

The student essays deepened my conviction that there is no single definitive formula for what makes a great teacher. The striking difference between the AP Calc students and the more academically and emotionally needy Integrated Math students made it clear to me as never before that the needs and preferences of these two categories of students are so different that what constitutes a great teacher will be different for each category. Furthermore, individual preferences and needs also vary for every student within each category.

Therefore, asking what makes a great teacher is like asking what makes a great lover. As crude as that may sound, I am dead serious. A teacher who seems great to one student may be seen as mediocre by another. I refer again to my classmate who disparaged the English Professor I considered to be great. This makes it a very good thing that we have many teachers. It increases the probability that every student will find at least one of their own great or master teachers that impact their lives for the better.

As a result of this day I found myself closing in on what makes a great teacher. But it would take me some time longer to attain my own personal Summa.

## Day #19: Physics and the Human Light Bulb

After a 3-week safari in Southern Africa I returned to the Sub Pool. I ignored the calls on the first day back, when I didn't quite know what planet I was on. Then almost two weeks went by without a call. Finally, on the Friday before Columbus Day the entire school district seemed to take an early holiday so I got the pick of the litter. I accepted the call for Physics at Hillsdale High even though it was the furthest school. It turned out I was to Sub for the most frequently cited best teacher of the survey I had conducted last time. I prepared the night before by reviewing several chapters of the first year of University Physics since three of the classes were AP Physics. I decided to lecture on the physical power we humans expend just by being alive.

Mr. B. was absent two days before I got there and the Subs on the earlier days probably had zero or less knowledge of Physics. Let me correct that statement. The Subs certainly had zero or less knowledge of Physics. So, little wonder my assignment was to show videos. Ugh!

The classroom was linked by the supply room to the other physics classroom – the one I had previously subbed in, so I got to meet Mr. C., the physics teacher I had just subbed for on Day #18. I was free the first period so I asked Mr. C. if he were OK if I watched from the back of the room. He was fine with it, so I attended his lecture.

The subject was inertia and he illustrated it with a video and with several demonstrations that really excited the kids. First, he spread a tablecloth over the lab table and placed several dishes and a glass of water on it. The kids were buzzing with excitement and several took out their phones to video the demo. Then, like a magician, he snapped the tablecloth out and the dishes shivered but remained almost exactly in place. Several students asked him to do it again, and he did.

For his second demo, he had drilled a circular hole in a block that fit tightly on a broomstick. He held the broomstick in one hand and a hammer in the other. When he hammered the broomstick down the block jerked up on the stick.

For the final demo, he balanced a wooden embroidery hoop with a diameter of about 15 inches on an Erlenmeyer flask with a 1½" wide opening that was partly filled with water. He placed a quarter on the top of the hoop, took a stick and whacked the hoop. The quarter popped into the air. He showed the class why. Whacking the hoop deformed it into a vertically elongated ellipse that launched the quarter. So, how to get the quarter to fall into the flask? The class couldn't guess. The next time, without telling the class what he was doing, he whacked the *inside* of the hoop. That converted it to a horizontally elongated but vertically

squashed ellipse. Since the hoop's top accelerated downward faster than gravity as it was deformed the quarter simply fell straight down into the flask. Even after he repeated the demo none of the students were able to explain or even guess what had happened. Why? First, it was too fast for the eye to see. Second, the students were not able to apply or even think of applying the fundamental physics principle (acceleration) involved. Perhaps they might have if they had seen time lapse photography of the experiment.

It was an excellent lecture. The teacher wove history and physics together and interfaced well with the video, turning it on and off at critical points to make critical points. Afterwards, when I complimented him, he said he wished he had been more organized (I didn't see how that was possible) and that lectures that introduce topics are better because they have exciting demos and because the students don't yet have to do any of the hard work. The guy just couldn't take a well deserved compliment, but I think we can all sympathize with that one.

Mr. C. is also very handy and uses his technical expertise. Some eight years earlier, he and Mr. B., who were friends from high school, purchased (with their own money) overhead projectors which they mounted into the ceiling complete with Surround Sound. That's far more than I had ever done at City College. Mr. C. told me that when the school administrators came by and saw the system, they got so jealous that within a few years they somehow scrounged up the funds to install overhead projectors throughout the school. Jealousy, like competition, is one of the greatest motivating forces.

Greatly impressed, I returned to my classroom. Four of the 5 physics classes were almost full, with 35 students each. When the students poured into the room I introduced myself. A few of them had seen me back in August and gave nice smiles. I then reminded them about the survey and told the others about it. When I mentioned who won the worst teacher title the mere mention of her name brought laughs. One of the kids said that there were rumors she was coming back and that she had not been fired after a semester. I told the kids it was their moral obligation to speak to the principal or some administrator about terrible teachers. A few said that they had but it had done no good. After all, how often do administrators listen to students?

I then said that the great teacher mentioned more than any other was in fact their physics teacher, Mr. B. The kids indeed did like him, saying he was cool and smart with a good sense of humor, etc. So I said it was an honor to sub for him.

The students were interested in the results of the survey and got quiet. While they were quiet I told them that my job was to show a video but that first I would give a short physics lecture. It went like this.

“One of the subjects in Physics is Power. Let’s see how much power we human heat engines generate. To start, tell me the power of a reasonably bright light bulb.... Yes, 100 Watts is right.

Power is expended Energy,  $E$  divided by time interval,  $t$ ,

$$P = \frac{E}{t}$$

The standard unit for power is the Watt. What is the standard unit of Energy using kilograms, meters and seconds? Yes, the Joule. Great! So, a Watt equals a Joule per second. Now, how do we get energy? That’s right, from food. How much do we eat per day? Right, about 2000 Calories per day! You will soon see in your Physics class that 1 food Cal = 4186 Joules. Now, since the time unit for Watts is seconds, tell me how many seconds there are in a day? Wow, you’re right, 86400! That was fast!!! So, human power is roughly,

$$P_{\text{HUM}} = \frac{E}{t} \approx \frac{4186 \times 2000}{\text{day}} \approx \frac{10^7 \text{ J}}{10^5 \text{ s}} = 100 \text{ W}$$

That means we are like bright light bulbs. By the way, the brain uses about 20 Watts, or about 20% of the body’s total power. So our brains are like a few Christmas lights.

Psychologists conducted an interesting experiment regarding brain power. They divided a class of 40 students into two equal groups. Twenty were given a difficult, 45 minute test while the other 20 vegged out in the lounge. Then all 40 went to the cafeteria and unbeknownst to them, what they ate was measured. The students who had taken the test ate more calories because they had expended more brain power.

The moral: when you study hard for a test or to learn something that is difficult you feel tired because you have burnt real physical energy doing it. I never realized that as a kid.”

I watched the kids as I said this and was surprised that I did not see any aha moments in their eyes. What registered? It could not tell.

Then, the regular Physics classes saw a video about the world seen with microscopes. One part of the video kept enlarging human skin until it showed head lice and a scabies mite that had burrowed into the skin. All the kids found it disgusting. That brought to my mind the Second Book of *Gulliver’s Travels*. In the land of Brobdingnag, Gulliver was treated like a miniature pet by 60 foot high giants. When he looked at

their skin, even the skin of the young girls, he was disgusted by the pocks. Swift wrote that in the light of discoveries made during his youth by Anton van Leuwenhoek and Robert Hooke using the microscope.

I thought it was a great point to link science with classical literature, but it fell dead on the students since only one boy had read *Gulliver's Travels*. I walked over and told him about the link. He liked the attention, the validation, and the information.

Almost all the students in that class, and especially the girls on the east half of the room, were extremely rude. They never stopped talking and nothing I did could shut them up. The students in the good, west half of the room told me that the bad half was hopeless and even Mr. B let them be. So when I gave my little lecture on Power, I walked over to the good half and talked quietly to them. The bad half had no idea what they were missing and cared even less.

They did quiet down somewhat when I quietly took attendance but no sooner were their names called than the uproar roared up again. I just turned the volume on the video high enough so that anyone who wanted to hear could.

After seeing the video the first time I recalled driving down to Georgia and seeing a sign of a fast food restaurant far down the road and right in front of the setting sun. I could read about 10 letters in the width of the Sun, whose angular diameter  $\approx 0.5^\circ$ . This means that just about the smallest features we can decipher details of has an angular width of about  $0.05^\circ$ . Given that angle, whose sine or tangent  $\approx 0.01$ , and the fact that young eyes can see objects clearly that are about as closely as 10 cm or 100 mm, the smallest object we can decipher is about 1 mm. To see features in any smaller object you need a microscope. So I also told the classes about that limit to human vision. I then recalled reading that David Landes pointed out in his book, *The Wealth and Poverty of Nations* that the invention of glasses shortly before 1300 CE in Venice effectively doubled the span of human intellectual productivity. It impressed me and I repeated it to the class. I don't know if it impressed any of the kids.

As the day ended, the kids genially bade me a good weekend as they raced out of the class. Perhaps they were on their way to the school's football game. Perhaps they were on their way with their family to Yosemite National Park or Redwoods National Park or Sequoia National Park or Kings Canyon National Park. Oops, I forgot – as I write, these magnificent parks remain closed by the latest iteration of government shutdown. How ironic – these natural wonders might be just about the only thing that could inspire some of our foolish, closed-minded politicians to take a fresh breath and act in a kindred spirit with the

nation, and for that matter the world, they were elected to represent and improve. Considering the quality of our politicians, you might judge that the schools haven't been doing such a good job. And then again, maybe it ain't the schools' fault.

## Day #20: English and Moby Dick: Speak Up and Write

The call came to substitute in English at San Mateo High. I welcomed it as an opportunity to branch out. And, for the first time, the teacher left the lesson plan on the AESOP System. That gave me a unique opportunity to prep the night before.

The two AP English Classes were reading *Moby Dick* (which I had read 2 or 3 times). I got out my Pocket Book and read the Afterward.

The 9<sup>th</sup> grade class – of poor students – was reading *13 Reasons Why*, a novel by Jay Asher. I didn't look it up on the Internet the night before class but did later and found out that it was a best seller. It consists largely of texts of audio tapes sent by a girl who committed suicide to people that she felt bore responsibility for the misery that helped lead her to it. The narrator learns from these tapes to fill the role of the guardian angel similar to Clarence in the film, *Its a Wonderful Life*.

I started each class with a survey that I introduced the following way.

“Good morning! I subbed here last year and also at Aragon and Hillsdale. I'll introduce myself but first I'll give you a survey. I give surveys to many of my classes and when you are finished I will tell you about the last survey that I did. The results were very interesting. I will also tell you a bit about myself, so that you can get to know who your Sub is.

So, please take out an 8½ by 11 sheet of paper. Print your last name and first name at the top. Then rank how much you like the book on a scale of 0 (hate) to 10 (love) with 5 being neutral, and most important, give reasons for your choice. Rate the book only on how much you like it – not on how important or great a piece of literature you think it is. Finally, name your favorite novel(s) and the author(s).”

In the AP classes almost everyone took out a piece of paper immediately. One or two of the 56 asked, "Can we split a piece of paper?" to which I said, "No!" The students quickly started their responses.

In the 9<sup>th</sup> Grade English Class very few of the students took out a piece of paper. Many did not bring any paper, and made a big show of mooching from the few who did. Many of those who did bring paper sat there inertly and had to be asked numerous times before they were brought to life.

In the AP classes there was a great uniformity of opinion. The almost universally repeated comment was that Ishmael, the narrator frequently went off on tangents that slowed the action and detracted from their enjoyment of the book. Another frequent comment was that although Moby Dick is ostensibly an adventure story, it is also an allegory and that

Ishmael is always philosophizing, sometimes with questions but no answers. I could not tell and did not ask if they thought of that on their own or if they were merely repeating what their teacher had said. In any case, their ratings averaged 5.6 and their average answer had 8 lines of printing. Only 4 of the 56 students did not or could not answer the question of their favorite book.

The students in the 9<sup>th</sup> grade English class needed much more time to complete the surveys, and their responses were scantier and much more varied. The average answer had 3.5 lines of printing. Few answers contained coherent reasons for the choice. A typical poor response was, "On a scale of 1 to 10 I would give it an 8 because it [is] interesting in a lot of way[s]." [Many poor students waste time and effort by repeating the question in their answers.] The ratings averaged 7.4, which was significantly higher than the average of the students in the AP classes. They were dealing with different books, but, given the high ratings, you might find it odd that 11 of the 17 9<sup>th</sup> graders did not or could not answer the question of their favorite book. One cynical conclusion to draw from the comparison between the two classes is that nonreaders enjoy reading more than readers.

Motivation for reading and writing often starts with love of books and reading transmitted by parents. Stimulating the love of reading in students whose parents have not transmitted this love is a consummately difficult task for a literature teacher. Hints might come from seeing what turned on professional writers, as recounted in the anthology of essays, *The Most Wonderful Books* by Michael Dorris and Emilie Buchwald. Ellen Howard noted in her essay, *The Magic of Reading*,

I did not learn to read until first grade, but it seems to me now that Mrs. L had only to present me with a "magic decoder" in those first weeks of school, and I was reading....Learning to read for [my siblings] was agony. They found no magic decoder....

I must conclude from my own family's experience that a love of reading is a special inborn gift....It has to do with who we are and to what we aspire. It has to do with our individual weaknesses and strengths. I do not love mathematics or mechanics or sports, though to live fully I need some understanding of these things. I do not believe that *everyone* can, or even should, *love* to read. But everyone, I believe, needs, at least, to know *how* to read.

After that, it is up to the books themselves to work their magic where they will.

In a way, finding the key to turning people on may be more difficult than decoding the Enigma Machine's encryption system.

Sherman Alexie, a Spokane-Coeur d'Alene-American, found reading to be a way out of the dead end life of (or on) the Reservation. His tale made me weep over his noble struggle.

My father loved books and since I loved my father with an aching devotion, I decided to love books as well....

I still remember the exact moment when I first understood, with a sudden clarity, the purpose of a paragraph...a fence that held words....This knowledge delighted me. I began to think of everything in terms of paragraphs. Our reservation was a small paragraph within the United States....

A smart Indian is a dangerous person, widely feared and ridiculed by Indians and non-Indians alike. I fought with my classmates on a daily basis....As Indian children, we were expected to fail in the non-Indian world. Those who failed were ceremonially accepted by other Indians and appropriately pitied by non-Indians.

I refused to fail. I was smart. I was arrogant. I was lucky. I read books late into the night....I loved those books, but I also knew that love had only one purpose. I was trying to save my life....

Back to the survey! One 9<sup>th</sup> grader sat paralyzed until I came over to him and said, "**You must feel something about this book.**" He said that he did, so I said, "**Then, say it to me.**" He then said that "I like it because it's true to life." I responded, "**Great, now write what you said**", and he did. I also said to several students, "**If you have trouble writing, speak into your phones to record and transcribe your words.**" It is a valuable hint that needs to be stressed for many reluctant writers.

The paralysis that too many poor students experience to translate their talking into writing involves several factors. First is lack of training. Second is lack of ability. But third, and not least, is fear. I didn't think of that until my 90-year old mother, Rita pointed it out to me the next day. Mom's response regarding this student's paralysis was, "He is a coward." She did not mean to disparage – she was just stating a fact. "His parent(s) have criticized him all his life. They feel stupid and have told him repeatedly that he is stupid. So he is paralyzed." The irony is that the kids who are more prone to assail you in a dark alley are precisely the ones who, in their turn, are most likely to be intimidated when asked to write something or solve an equation in a classroom.

It wasn't until months and months after the day was over I first felt competent to teach writing well. Teaching how to write must start with identifying the elements. Of course writing starts with words. They build to sentences that build to paragraphs. But I had never been taught and never knew until my wife and her friend who taught English taught me that a standard school essay consists of 5 paragraphs:

1. Introduction
- 2-4. Body with real or imagined facts and logic
5. Summary or Recapitulation.

Rafe Esquith provided a compelling framework for structuring and reviewing fiction in *Teach Like Your Hair's on Fire*.

1. Protagonist – The Hero
2. Antagonist – The Villain
3. Conflict – Often Good vs. Evil
4. Setting
5. Plot
6. Climax – Turning Point
7. Denouement - Resolution
8. Theme – Fundamental Idea

For example, there is almost always a protagonist and an antagonist – which can simplify to a hero and villain. None of my teachers ever presented such a simple framework for constructing a book review. (Or was I in a fog when they did?)

Consider professional wrestling matches. The wrestlers are highly trained athletes but are rarely competing. Their struggle is carefully choreographed to fit the above skeletons. The hero and villain march into the ring, setting the stage for the primal struggle between good and evil. In most cases the villain is inferior and must resort to vile tricks. The match starts with the hero's display of superiority followed immediately by a villainous trick that injures the hero. The bulk of the match involves the hero's prolonged suffering at the hands of the inferior villain. But in a sudden burst of superhuman recovery, the hero pins the villain and the match ends in the blink of an eye with good triumphing over evil. The villain never suffers to the degree that the hero does.

Incidentally, having played judo for two years I know enough about it to see that for almost all throws in professional wrestling the person being thrown actually jumps. Without that jump the throw could not have

been successful – just watch real wrestling or judo matches, where such poetic throws are quite rare.

Rafe's outline got me to look up the difference between Climax (Apex or Peak) and Denouement (Resolution), which led to the subject of Dramatic Structure and thence to Frytag's Pyramid, based ultimately on Aristotle's *Poetics*.

1. Exposition
2. Rising Action
3. Conflict
4. Falling Action
5. Denouement

Perhaps the most complete brief and handy diagnosis of writing is *Perrine's Literature Structure, Sound and Sense*. This thorough guide and anthology has gone through multiple editions. I am sure English teachers know it well but I was lucky to see it by chance in a Goodwill Store. To me it was new and a revelation. It diagnoses the elements of fiction, poetry and drama. Why none of my English teachers assigned it or some similar work remains a mystery to me.

All these frameworks help diagnose how authors structure many books, movies, and plays. Using them, I feel at last I could now (two years later) teach English writing and literature better.

All this is much too much to convey in a single period. When a regular teacher has a revelation about a student or a teaching technique, he or she can return to the class to help the student anew or attack the problem. Subs must have instant insight. Subs get no second chance.

Well, that is not entirely true. Sometimes, Subs do get a second chance, and may get through to the students more than they realize. A tall student walked into the last period AP class, looked at me and said, "I know you – you subbed in Spanish last spring." (Day #17.) He then said that although he had thought about the book I had recommended on Fairy Tales he hadn't read it. I reminded him – *The Uses of Enchantment* by Bruno Bettelheim.

I asked him which Spanish class he had been in, certain that it was the last period class, where I knew that I had the students' undivided attention. No! It was the chaotic class where I sent 3 rowdy students to the Dean. I had assumed that no one had heard me at all in that class. I guess one lesson is, "Never underestimate your students or yourself."

After the surveys I introduced myself and told the students how I discovered *Sindbad the Sailor* in the attic of our house when I was 9 and was entranced by it. I briefly described the *Arabian Nights* and told a

tidbit of *Sindbad*, so that they clamored for more. (Everyone loves stories.) In the AP class I also spoke briefly on *Moby Dick*. In the time before class I reread the first few chapters. Ishmael rhapsodized that the Battery of Manhattan was "washed by waves, and cooled by breezes, which a few hours previous were out of sight of land." Now, I am sure that that sentence breezed right over the heads of every single student but it gave me, as a meteorologist, a key to understanding a part of Melville's genius.

"Do you know, my AP geniuses, that here in this single sentence is a beautiful and accurate description of the sea breeze? The sea breeze is what air conditions San Mateo all summer. The ocean is icy cold during summer, about 52°F, and chills the air over it while the air over the land of the Imperial Valley gets real hot – often over 100°F. Hot air is light and rises. That leaves a void at ground level, so the cooler, denser air from the sea blows in to take its place. That air is perhaps 65° at Half Moon Bay. By the time it reaches San Mateo the hot ground has warmed it to about 75° F. After it crosses the Bay it continues warming. And, as Ishmael described, a few hours before the cool air reaches San Mateo it was far out at sea, out of sight of land."

Ishmael's next commentary concerned fresh air and politics. As the ships sail into the wind, the common sailors in the foredeck get the air first and the Commodore gets 2<sup>nd</sup> hand air. And as Ishmael points out, "In much the same way do the commonality lead their leaders in many other things, at the same time that the leaders little suspect it" – an interesting way of seeing politics!

Finally, I gave the students their assignments. This was a day of block schedules; periods were 90 minutes long. In the AP classes the students immediately divided into groups and began doing what they were doing. Many, but not all worked. Some talked. In the 9<sup>th</sup> grade class, the students took considerable time to get their acts together and many never did. Only two girls did the assignment. But several boys did get help for their Spanish homework. The fact that they did anything constructive was enough for me. So, I left them alone.

A few of the 9<sup>th</sup> grade boys squeezed sponge balls given to them to assuage tension (or hyperactivity). After they threw the balls about 5 times (in blatant violation of the rules for their use) I calmly confiscated them. I simply walked to each culprit's desk and held my palm up until it was filled. I did it silently and patiently but with a knowing smile. So, the boys knew that I was on to their game.

When the period was over I was surprised when many of them said that they thought I was a good Sub. I was really grateful and thanked them. I had been genial. It pays to be genial. As it turned out I had played

it right. I played it right because I felt it right (and because the kids weren't abusive). For, all along, what I secretly felt was that these mostly sweet kids have poor options for their future. In a society where the Grand Canyon is a miniature model of the disparity of wealth that continues to widen and deepen rapidly, odds are that most of these students will be left swirling in the rapids, gulping mud water, and lucky to crawl out exhausted on either bank of the canyon floor.

I thought of telling them about their poor prospects that they needed to rectify. Then I looked at them, these sweet victims, and said inwardly, "revealing my 'profound' insights to them would only hurt them." We would have to know each other much longer and much better before there was any possibility they could absorb any part of such tough love. Because I am a Sub, that is not part of the scheme of things. But reflecting on the day I noticed that my geniality has increased along with my confidence and as my nervousness has diminished. I now have enough freedom to like the kids more. Of course it helped that the kids did not start off hostile. Subbing has finally gotten to be fun.

## Day #21: What the Kids Think

I was back in Physics at Hillsdale. This time I was in Mr. C's class and got to meet Mr. B. Some of the kids knew me already, and since I had subbed in the 3<sup>rd</sup> period Physics class on Day #18, all of the kids in that class knew me.

The assignment was the usual – show a video. It was the same video as the previous time – *The Invisible World*. I gave the same little lecture on the average power of the human engine. I needed help to start the video because it was in the wrong machine and on the wrong channel.

I told the students that I was writing a book on my experience as a Sub and then gave them my survey question, "Tell your good and bad experiences with Subs and what makes a Sub good or bad." There was more agreement regarding reasons that made for a bad Sub. Of the 69 responses, 29 stated that the worst Subs were needlessly harsh or mean or ineffectively strict and 24 stated that the worst Subs either lacked knowledge or tried to teach despite their ignorance or simply provided an hour without learning. Six thought Subs were "weird" and 8 accused the worst Subs of not caring or outright disrespect. The best Subs were the ones who let the kids pretty much alone (9 votes), were "cool, chill, or friendly" (8), fun (7) were easy (5), helpful (5) or knowledgeable. There wasn't a single mention of a Sub who actually taught them something that stuck, exactly what I have hoped to do.

One of the girls turned 180° and talked incessantly. There were some talkative guys on the Football Team. But they were quieter in their rowdiness. I have never taken statistics, but it is almost always the girls who do the 180°. When I confronted this girl with that observation and asked her to explain it, she said that is because girls are more talkative. But that's not why. This is the more passive-aggressive way that girls are more apt to act. Eventually I demanded that she move two seats forward. I think she knew that I meant business. But when I turned back the second girl had also moved two seats forward. I told Girl #2 to get back and she did. There was fire in my eyes. It worked but I should have learned from *The Devil and Daniel Webster*.

Mr. B. told me that some of the students had discussed with him what they had done when I was the Sub. So it did register. But then again, the bulk of the students simply want a chill, easy, do-nothing day when a Sub shows up and looks genial and benevolent.

## Day #22 Math at San Mateo: The Power of the Grapevine

I decided to put the last survey to action. I would have the students vote on two items, 1: Do you want me to tell about myself, 2: Do you want me to give a short lecture with a problem?

I had an inspiration on the walk to school. A man asked me, "Do you have a dollar for a cup of coffee?" I responded obnoxiously, "**I have five dollars for a cup of coffee**", and continued walking without giving him anything. I would be more generous with the students. If the majority voted yes for the lecture, I would announce a surprise \$20 prize for the first student or group of students who could solve the problem within 10 minutes.

You can guess what happened! In the first class (Geometry), 24 of 26 students voted to hear my bio but only 4 of 26 wanted the lecture. I then told them not only did they miss the lecture, they missed the chance at a \$20 prize. The few students who voted to have the lecture asked me to give them the problem. "**Too late**"! I then gave the day's assignment, and they got to work.

Period #2 was free. Period #3 was AP Calculus. They voted 19 to 2, to hear my bio but only 8 for the lecture. I also told them that they had missed the chance at the \$20 prize.

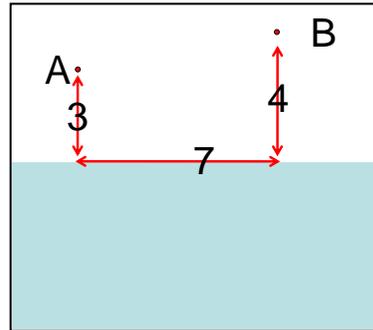
After the bio I gave them their assignment. While walking around the room, I asked what they wanted to major in in College. Most mentioned engineering or science. One East Asian student mentioned parental pressure. This was a problem many of my East Asian students at CCNY had confessed to me. I told him to tell his parents that he had robbed a bank, had \$5 million and was so rich they didn't have to worry about his career choice. I think I kind of stunned him and never will know what he was feeling. But I may have conveyed my message, namely, choose what you want. It's your life, not theirs.

One girl showed particular interest in my bio, voting out loud in an attempt to sway her classmates. When she mentioned that she might want to be a rabbi I told her about our friends' brilliant daughter – Harvard and all – who made every Med School her mother applied for but who became a rabbi. At the end of the period, the girl said, "You have no idea how we have bonded," and I responded, "**You might be surprised**." But I was skeptical. Can anyone's impact can be that great that fast? I should have asked her how we had bonded.

The Period #4 Geometry class barreled noisily into the room. When I got them settled and took the vote knowing glances filled the room. The vote was 19 to 10 for my Bio and 22 to 7 for the lecture and problem! They didn't want to waste time or money.

What is the probability that such a sudden, spike of interest in the lecture and problem was random? Clearly, they heard it through the grapevine. I was impressed by its rapidity and thoroughness. Their teacher better not give the same test to the later period classes!

The problem I gave them was one that my much older cousin, Shragga Irmay, a brilliant Professor at the Technion gave me when I was taking Geometry. “Find the shortest path from Point A to Point B that touches the straight river (Figure 11). Point A is 7 units west of Point B and 3 units north of the River while Point B is 4 units north of the river.



**Fig. 11. Find the shortest distance from A to B touching the Blue River**

I insisted that the prize would only be won if the students gave the correct reason as well as the correct solution. Before looking at the answer (Figure 12), try to solve it for yourself.

Most students spontaneously formed groups. Some made repeated guesses, asking each time if they were correct. Many students suspected that the Pythagorean Theorem was involved and calculated diagonal paths at various points on the river. Several students gave two choices, one diagonal and one with purely E-W and N-S segments. They found that an arbitrary diagonal path was shorter and asserted it was the shortest path of all. Given that there are an infinite number of diagonal paths, they missed the essential nature of the generality of geometrical proofs.

One group did try several alternatives, ultimately hit upon the correct path, and showed that some nearby paths were longer. I decided that was close enough for \$10. It wasn't until the next period that I realized that their approach, though incomplete, was essentially that of the Calculus – they were crudely taking limits, and I should have pointed that out to them and perhaps have given them \$15. But again, woe is me, to disappear without a second chance is the sorry lot of the Sub.

Now for the answer to the shortest path problem, shown in Figure 12! It is based on the principle, “**A straight line is the shortest distance between two points.**” The ingenious solution is to create an image point  $B'$  4 units south of the river bank directly south of point  $B$ . Then draw a straight line between points  $A$  and  $B'$ . The point at which this line touches the river also gives the shortest path from point  $A$  to  $B$  that

touches the river Any path from  $A$  to  $B'$  that touches another point on the shore would not be a straight line and therefore would be longer.

The Period #6 class filed in without much enthusiasm, but they had also heard it through the grapevine. They voted 22 to 2 to hear my story and 16 to 7 for the lecture and problem.

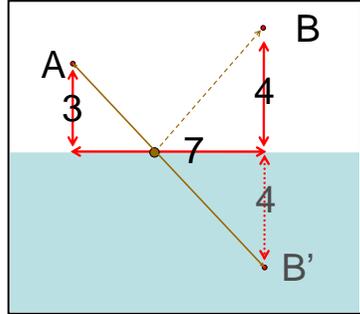
I gave them a different problem – find the area of an equilateral hexagon one unit long from the center of the hexagon to the center of a side (see Figure 13). This was way beyond their capacities that early in their geometry course. So, most gave up immediately. Only one group researched the problem and saw how their text calculated the area of a pentagon, but they couldn't extrapolate from it. Guesses were all over the place – up to 720! Many of them could not see that an object about 2 units high and wide should have an area of about 4. And again, as with the first class, the nature of a general of geometric proof escaped many. They equated guesses with proofs.

The solution requires several steps. Step #1 is the step of genius. Once you think of it, the rest is pedestrian (if you know Pythagoras).

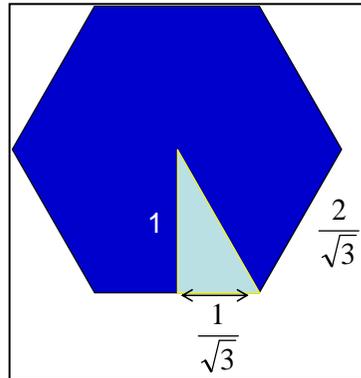
Once you think of it, the rest is pedestrian (if you know Pythagoras).

1. Divide the equilateral hexagon into 12,  $30^\circ - 60^\circ - 90^\circ$  right triangles.
2. Use Pythagoras to find the hexagon's sides,  $c^2 + (c/2)^2 = 1 \Rightarrow c = 2/\sqrt{3}$ . Each right triangle's base is half this,  $b = 1/\sqrt{3}$
3. Hexagon Area =  $(\frac{1}{2}bh) \times 12 = 6/\sqrt{3} \approx 3.46$

When I got home I told my wife, Bernice what I had done. I was surprised at how negative she was. She felt that bribes for students were taboo. Indeed, they are risky motivators. In *Predictably Irrational* and *Payoff: The Hidden Logic That Shapes Our Motivations*, Dan Ariely pointed out



**Fig. 12. Draw image point  $B'$ . Connect to  $A$  with a straight line.**



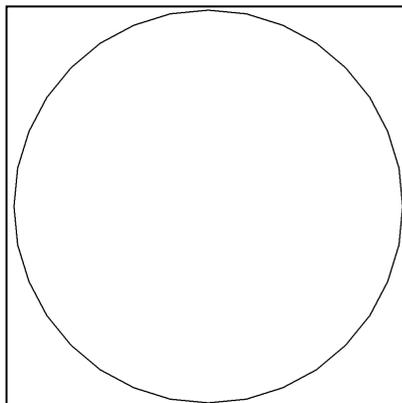
**Fig. 13. Finding the area of an equilateral hexagon.**

that cash bonuses initially spur workers to increase productivity, but their net, long term effect is to decrease productivity. Hey! A short term benefit is perfect for a Sub!

## Day #23: Subs Sometimes Do Get a Second Chance!

Surprise! The math teacher found out that I know Calculus and specifically asked for me. I felt my return was more important for the Geometry classes so I planned a brief demonstration about how Geometry can lead to Calculus. I had my computer draw the 32-sided equilateral *triacontadigon* (I looked up the name) of Figure 14.

Unless you look very closely, you would almost bet your life it is a circle. I also had the computer draw a circle with both an inscribed and a circumscribed hexagon. With these drawings, I walked into class.



**Fig. 14. A 32-sided polygon looks like a circle.**

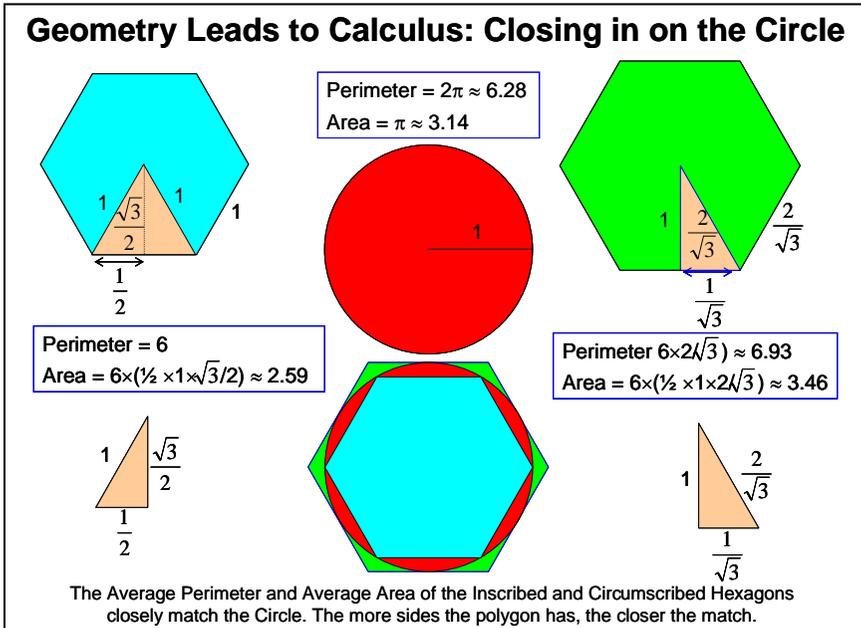
The students were glad to see me, and that made me happy too. I began with the work I had prepared, showing how to use polygons to get to the doorstep of Calculus. Holding the triacontadigon up in front of the class, I asked, “What’s this?” Everyone said, “It’s a circle”. “Are you sure?” Then I passed it around so that everyone could see it close up. The first person noted the slight angles and the straight lines and announced to the class that it was a polygon. Everyone in their turn agreed. That was my cue.

“This polygon is similar to a drawing my high school geometry teacher, Mr. Richards, showed my class years ago. I remember how amazed I was. I didn’t know it then, but he had shown us one of the keys to Calculus. Yesterday I asked the last geometry class to find the area of a hexagon. They couldn’t do it. Today, we will find the area of a hexagon and then use it plus Archimedes’ 2200 year old trick to estimate the area and perimeter of a circle and the value of  $\pi$ .”

The trick to find the area of a polygon is to break it down into triangles because we know that the area of any triangle =  $\frac{1}{2}b \times h$ . You can subdivide an equilateral hexagon into 6 equilateral triangles and each equilateral triangle can be subdivided into 2 right triangles, as in Figure 15.

Once you find the hexagon’s area and perimeter it is time for Archimedes’ trick to find the area of a circle. Draw two hexagons – one that touches the *inside* of a circle and a second that touches the *outside* of the circle. The inside or *inscribed* hexagon has a smaller perimeter and

area than the circle. The outside or *circumscribed* hexagon has a larger area and perimeter than the circle. For a circle whose radius,  $r = 1$ , the average perimeter of the two hexagons  $\approx 6.46$  compares to the circle's perimeter of  $2\pi$  while the average area of the two hexagons  $\approx 3.02$  compares to the circle's area of  $\pi$ , so that the approximations for  $\pi$  based on perimeter and area are 3.23 and 3.02 respectively.



**Fig. 15.** Using hexagons to estimate a circle's area and perimeter and  $\pi$ .

Those approximations are not highly accurate. Polygons with more sides produce more accurate approximations. Archimedes worked his way up to polygons with 96 sides. For a polygon of 96 sides, the approximation for  $\pi$  is 3.1428. That's real close to 3.14159."

On the personal side, I asked the girl who had said I could have no idea of the impact I had on what she had meant. She hesitated at first but I wouldn't let her off the hook. She said that she had been in a summer program in Boston, MA to help kids. The Program Leader, her mentor was an inspiration to her and I reminded her of him. She thought that I might be insulted but I felt complimented and told her so.

In the third period class I told the group that almost got the solution of the shortest path problem that they had in fact reinvented the Calculus technique of taking limits and I was proud of them. So I gave them an extra \$5. The whole class loved this.

Next, I wanted to demonstrate and emphasize the general nature of geometric proofs. Understanding the nature of a proof is a central part of Geometry, and indeed, of many fields. This must be stressed much more, but it's a tough concept that takes time to absorb.

Recall that several groups of students thought that because they found the shorter of two paths in Figure 11 that they had found the shortest possible path. So, I asked two of the taller girls in the class to stand up. I picked the shorter of the two and said, "You are shorter than your friend. This proves that you are the shortest girl in the class." The students quickly and vehemently pointed out the fallacy in my logic. I had not looked at anyone else in the class. "But that is exactly what some of you did when you picked two paths and insisted that the shorter of the two was the shortest path of all."

The day's subject in geometry was similarity. Here too, the notion of generality eludes most of us. The class had been dealing with similar triangles and had just covered similar polygons and the idea that area is proportional to length squared =  $L^2$ . But when I gave the classes the following problem, the ability to generalize still eluded them.

"Gulliver came to the land of Lilliput. He was 6' tall and the Lilliputians were 6" tall. So, how many Lilliputians will it take to eat as much as Gulliver eats?"

Many students said that Gulliver would eat as much as 12 Lilliputians. That makes sense until you realize that not only was Gulliver 12 times taller than a Lilliputian, he was by similarity 12 times wider and 12 times thicker, so that his volume would be  $12 \times 12 \times 12 = 12^3 = 1728$  times larger than a Lilliputian. But none of the students thought of volume. Neither had most of my college students, and that included the science majors.

To dramatize this, I compared the heights and weights of a newborn baby and an adult. The average newborn is 20 inches long and weighs 7.6 pounds. Since an average adult is close to 70 inches or  $3\frac{1}{2}$  times taller than a newborn, if weight were simply proportional to height, an adult grown man should weigh almost  $3\frac{1}{2}$  times 7.6 pounds or almost 23 pounds. Because everyone realizes this is ridiculous, it forces them to rethink their proportions. But it is still a tough concept to grasp.

As a professor I gave another example when teaching how raindrops grow. Most of the droplets that make up clouds are far too tiny to fall to the ground. To reach the ground they must grow much larger. One way they grow is by combining or coalescing. I then took out two spherical beakers. One had twice the radius of the other. The question: how many small spheres full of water are needed to fill the large sphere? Most students guessed 2. A few guessed 4. Only the exceptional student

guessed or knew it takes 8 because when the ratio of radii is 2:1 the ratio of volumes is  $(2:1)^3 = 8:1$ . When I did the demonstration, almost everyone was amazed. I was too even though I knew it takes 8. It is amazing because it is so visually deceptive.

A more fundamental problem is getting students (or anyone) to recognize the *nature* of a problem. Teach students the idea of similar triangles and give a few examples, and almost all can solve other problems of similar triangles. But though we all innately know the concept of similarity, giving a similarity problem without defining it as such always stumps them. Why? It requires 3 steps.

1. Recognize the *nature* of the problem as one of similarity.
2. Extend it to the appropriate number of dimensions
3. Solve it.

Most people cannot string these 3 tasks together.

In the Calculus class I introduced the logistic difference equation (the simplest equation that exhibits chaotic behavior), and illustrated the idea of Chaos with an analogy I used to give in a Saturday High School Science program. “Imagine a scene on the Subway. Person A pushes person B. Person B can either push back or absorb it. Person C can defend a passive person B or restrain an excessively aggressive person B. Alternatives multiply so rapidly it is impossible to predict the outcome.” I then solved the logistic difference equation for a couple of cases, telling them about the Butterfly Diagram and Chaos, and predictability. The students liked the presentation, which included iteration. I saw some eyes open and felt good.

This was one of the days I was given an extra class. The Administrative Assistant called and asked kindly if I would mind subbing in one extra class. Of course I said yes. I asked, “What subject is it?” Lo and behold, it was *Elementary Chinese*!

I told the students that I had subbed in many subjects but this was the first in which I knew absolutely nothing. So, they taught me a few expressions including how to say I am sorry, which I quickly forgot, as is my wont in trying to learn new words at my age.

Surveying the class I couldn't help seeing that every single student looked East Asian. So I asked each student two questions. "1. Are you Chinese? 2. Do you speak Chinese?" Of the 18 students in the class 17 were 100% Chinese while the other was half Chinese and half Filipino. Fourteen of the 18 were fluent in Chinese and the other 4 had some knowledge. So, I confronted them, "Are you kidding me? What are you doing in this class – just looking for an easy A?" Many smiled at this. I

commanded them, “Study and learn something else – Japanese, Hebrew – anything!” One student asked, “How about Korean?” “Of course!” I told them about being one of many Jews at CCNY when I had wanted to meet people with different backgrounds. I was happy at MIT, told them about the Africans who argued politics as if it meant something because they would be leaders in their countries when they returned, while our arguments were academic in a vacuum. The students got a kick out of my prodding. And they all genially confessed what everyone knew, namely that they were there to beef up their GPA’s.

Then I thought of some things that I do know about China. The Great Wall almost traces the 15" contour of annual rain, the necessary amount to grow crops. In this way it separated farmers who accumulate wealth, from nomads, who do not. Then I spoke of Chinese landscape art and how the Chinese cloud forms betrayed a link to Persian sky paintings in the early 1300's when the Mongols exiled Chinese artisans to Persia.

In the last class of the day, two girls said I was the best Sub. My head certainly was turned.

In all the classes I eased up – allowing a certain level of noise and only gently urging them to focus on their assignment. After all, Thanksgiving was approaching and then again there is the saying, "God grant me the serenity to accept the things I cannot change, courage to change the things I can and the wisdom to know the difference." I was easing up in the Lion’s Den.

Feeding the lions is another way to survive in the Lion’s Den. I gave out brownies and oatmeal raisin cookies to all the students, and when some in the later classes asked for two, I made a count and told them if there were any left at the end I would allow them another. They left very happy. In the later classes I gave out the brownies at the end of the periods, joking that way they could take their hyperactivity out on the next teacher.

In my last few years as a professor I fed my college lions for a good academic reason. One of the great conceptual difficulties in meteorology is to visualize the invisible atmosphere. In physics you can see a ball falling or a helium balloon rising, but air is an invisible field of fluid moving invisibly. Motion can be seen by inserting tracers, such as smoke or dry ice fog in the air, while a layer cake proves an excellent way to show how to depict the invisible atmosphere.

1: Looking down at a cake gives a map or bird’s eye view of the top of the cake or any level if you cut the cake horizontally. 2: Cutting a vertical slice gives you a panoramic, or cross section view of the inside of the cake. 3: Plunging a straw down into the cake and withdrawing the straw will reveal the layers while leaving the cake seemingly untouched.

This view is called a Sounding in the Atmosphere or a Core in the Earth, an ice sheet, or a tree. It is a sneaky way to assess the structure because it leaves a barely visible mark (in a cake or tree).

So, at the beginning of each semester I purchased one or two huge chocolate layer cakes (from COSTCO so that I wouldn't go bankrupt). After delivering a sober lecture in which I used the cake as part of the lab demonstration, I had the cake served to the class.

I never conducted any statistical tests to see if that cake demonstration improved the students' concepts of the atmosphere. But it made them laugh, it made them happy, and the chocolate surely kept them awake, so it must have had at least a few crumbs of positive educational impact.

After the last class of the day I met the math teacher, who clearly seemed on top of things. She has been teaching 10 years, was very bright and looked like a kid. Wow, am I getting old!

## Day #24: Math and the Nature of Applause

Math and PreCalc again in Aragon. Again I pointed out that the text doesn't mention the words derivative or integral, which are central to Calculus. I gave them the lecture on the roots of Calculus (from Day #9) and the Method of Exhaustion. One or two of the classes applauded.

Applause is rare in high school. I don't remember any teacher getting applause in my years in high school. So, why did the students applaud? They were surprised. Since most Subs don't know Calculus it is a giant surprise when a Sub comes in, looks at the assignment and gives a masterful overview. Curiously, this is one of the Sub's few crucial psychological edges over a regular teacher. Had a regular teacher given the identical lecture, the students would have expected it, would never have thought to applaud, and, not being caught by surprise, might not have paid as much attention.

Primary, secondary and beginning college students don't often applaud their teacher's or professor's lectures. Of course, young students take so many classes that if they applauded frequently their hands would fall off. In my senior citizen classes we applaud routinely and feebly after most competent lectures as a matter of courtesy.

What types of applause are there and when do we applaud? 1: There is perfunctory applause. We applaud anyone who stands up at a meeting and tells of raising \$1.57 for the group's charity. 2: There is mandatory applause. We are almost required to applaud at the end of Plays and Classical Music Concerts. The only way to tell if people liked a performance is from the level, duration, and delay of the applause. 3: There is enthusiastic, spontaneous applause. We applaud most spontaneously (even in movies where the actors are virtual) when a hero triumphs over great odds or a villain is defeated.

Applause is a muted or controlled response. When we're really swept away we don't applaud, but instead, scream, as in Rock Concerts or cheer or boo, as at Sporting Events, because in those environments our internal censors are turned way down.

An entertaining teacher has a much higher probability of receiving applause. To what degree being entertaining increases learning is less certain, though it does make a class more fun and increases the students' probability of remaining awake and attentive.

I always knew that entertaining professors get high student ratings and also assumed they do have a positive impact on learning. So, early on I developed standard routines for a number of lectures.

One humorous routine that would now bring only censure brought me some local fame early in my lecturing career. Before about 1975,

forecast accuracy for East Coast Snowstorms was poor due to lack of data and limited computer capacity and speed. As a result, some forecasts were utter fiascos. An example was the famed “Lindsay Storm” of February 1969, which paralyzed an unprepared New York City for a week.

To my class I soberly described all the difficulties involved in such forecasts and then to illustrate how the meteorologists felt when they “got caught with their pants down”, I took off my pants on the lecture stage. Of course, I had tennis shorts under my pants but for a few moments I acted as if I were naked below my shirt.

The class reaction started with subdued shock, followed by laughter and general jollity. What was the educational impact? Sorry to tell, a week or two later most of the students could not remember the educational purpose of my act. After doing this a few semesters, a student asked me at the beginning of one class, “Is this lecture the one where you take your pants off?” (It wasn’t, but it showed that the word had gotten around.) That sealed it! I never did it again.

There are many dramatic acts that a teacher can perform in the hope of improving learning or at least making the time spent in class more fun. Hopefully, these little dramas do not create a distraction so great that the educational point is sullied or sacrificed.

In one dramatic act I used a laser to illustrate crepuscular rays. When a laser beam shines across a darkened room all you can see is a red spot on the far wall where the laser beam strikes. But sprinkle some chalk dust or powder along the beam and the beam lights up dramatically. Thus I taught that all atmospheric optical phenomena including sky color, rainbows, and halos are produced when the path of light is disrupted and deflected. And that demo riveted every class.

My dramatic addition was inspired by the movie, *Goldfinger*, where James Bond is about to be incinerated by a laser burning through a slab of gold as it slowly moves toward his groin. I prepared an act in which one of the graduate assistants would ‘accidentally’ aim the laser beam at my groin, but only after I had completed a ponderous lecture on the extreme caution needed when using lasers and grossly exaggerating the damage it could cause. Immediately after I finished this long-winded warning in a most sober, straight-faced manner, the graduate assistant turned on the laser, which ‘hit’ my groin. I had turned slightly so that all the students could see the red spot of light on my pants in the groin region. I immediately leapt up with a blood-curdling scream, shocking every one of the 360 students. I’ll never know its educational impact, but it sure helped make me a popular professor.

Encapsulating knowledge in stories has great potential educational value. Here is one of the stories I told to great effect for several years back in the mid and late 1970's.

“Farmers discovered they could prevent or at least ameliorate costly frost damage on clear, calm nights in apple orchards and orange groves by mounting and turning on large fans. Only Farmer Nixon refused to install fans. The other farmers then explained to him that on clear, calm nights the coldest air is near the ground and the air perhaps 50 feet up can be over 10° C warmer. So, the fans stir the warm air down to where the apples are. Farmer Nixon said, “That’s ridiculous. You’re all crazy. Everyone knows that fans only cool things down.” So, one clear, calm night when frost warnings were issued, all the apples in Farmer Nixon’s orchard froze while all the other orchards, which had fans, did not have any frost damage. The moral of the story is that Nixon should not have been in apples. He should have been impeached.”

That story, with its PUNishing PUNchline always got laughs. But did it work? One of my former students, Joe R recently reminded me of this story. It had stuck with him for 40 years. So, it works with some.

Entertainment lowers resistance to learning but is also a distraction and so, must be used wisely and sparingly. Of course, the more anyone, students included, love a subject, the less they need such entertainment. This is just one more example where the subjective insight of the teacher is critical in optimizing learning.

## Day #25: Math, Method, and the End of Bribery

Again Precalc and Algebra and my Method of Exhaustion spiel. I derived the equations for the sums of arithmetic and geometric series. The kids recalled the equations but none had any memory of seeing the derivations. I preached to them.

“Math is logic with a little memory. Many other subjects, such as Bio, require much, much more memory. In Math if you know the derivation you never have to memorize the formula. Derivations in Math are like the roots of a weed. Just as you can pluck a weed but leave the roots, it will grow back, so too if you forget the formula but know the derivation the formula will always come back.”

I circulated the cartoon (Figure 1, Prelude) showing the difference between societal attitudes in 1960 and 2010 and watched how many smiled. Then I offered a total of \$20 for those who guessed correctly how many had smiled (8/19) provided that 3 guessed correctly. Four did, so they won. This was a stupid, pointless bribe. In the Calc class I gave a problem and one of the kids got close enough so I gave out \$20. I ended the day a bit poorer but the kids were turned on. Having gone overboard with bribes, I decided that I was done with them – except perhaps in a very rare emergency. Experimenting is valuable in teaching as in science. You keep what succeeds and abandon or modify what fails.

**Day #26: Pity the Sick Sub**

I had recovered enough from my first ever bout with bronchitis to Sub. I don't know how I had the strength to walk the mile to Aragon. I told the kids I was totally exhausted from being sick and they responded very sympathetically and behaved very well. Interesting I should have thought to play sick with some of the rowdy classes.

In the Pre-Calculus classes I asked if they wanted me to give a lecture on the origin of Calculus. Class #1 voted 7 yes and 27 no. Class #2 voted 8 yes and 24 no. Somehow, with no prospect of a prize and no riveting message to send down the grapevine, class #3 voted 16 yes and 8 no, so I gave my lecture!

The student aide in Class #2 and #3 was really bright and proactive, and a member of the math team. He reviewed the homework problems and gave really good explanations, and I acted as his assistant. After class he bragged to me that almost all the kids tried to rely entirely on rote memory and didn't think (whereas he, of course, did).

Despite the presence of the student aide, one of the kids in the class said that no one would help him when he had problems. I told him that someone would – he just had to ask. I don't know if he believed it. It is a good life practice to look for and accept help, and wisdom to realize it's often there for the asking. I should take my own advice more.

## Days #27-28: A Tale of Two Days

This was one of the few times I received an assignment a week in advance due to a scheduled meeting of science teachers. Before the scheduled meeting began and just after I entered the classroom so did the teacher, Mr. W. He informed me about the day's activities. I would sub in Biology in the morning and Geology in the afternoon.

We had a brief conversation. I noted that I had subbed for him back on Day #8, perhaps the worst day of my subbing career, the day of the "Integrated" Science class. He opened up, saying that that rowdy group of students had been the class from hell for him. After at least a decade of enjoying teaching, that class almost made him quit. He remained shaken by it. We commiserated, but I had only suffered one day and escaped with a feeling of freedom. He had been imprisoned – he needed the job.

It was Mr. W. who then informed me that 'Integrated' Science had been eliminated from Aragon High School's curriculum. Gracias a Dios! One more stupid Ed experiment tossed back into the revolving trash heap it should never have been salvaged from. Later, when I mentioned the temporary demise of Integrated Science to a retired teacher, he pointed out that in years gone by the red flag lingo for 'Integrated' Science was 'General' Science. A latrine by any other name...

Mr. W. and I recounted our backgrounds. He trained as a geologist and was ABD (All But Dissertation) for the Ph. D. He had done all the research and writing, but found as he went through grad school that he didn't want a Publish or Perish career as a professor, which has morphed more into DOD (Dinero [via Federal Grants] Or Death). When asked to make corrections by Committee members (which of course were to some degree contradictory) he simply gave up. By doing so he essentially forced himself to make the career decision he really wanted. Before he became a teacher, he worked several years in the Oil Industry, getting a strong background.

When we began to discuss the assignments for the afternoon, which involved El Niño and contour maps, I mentioned some features of the 1998 El Niño that he hadn't been aware of. He got excited and was very much in favor of me instructing the class. I admired him for neither showing nor having any jealousy that a lowly Sub might know more than a distinguished full time teacher did in some particular area. He was a true scientist – he did not invest his ego and showed primary respect for knowledge.

I in turn told him I was weak in Biology. Then he showed me the assignment for the day. Part 1, 30 minutes long, involved four of Earth's

grand cycles, the Hydrologic Cycle, the Carbon Cycle, the Nitrogen Cycle, and the Biogeochemical Cycle. Wow, I guess I know some Bio after all! I had taught the Hydrologic Cycle and the Carbon Cycle as a Professor. Part 2 of the day's work consisted of showing a Nature film called *The Queen of Trees* – the Fig Tree. Since it was a Block Schedule Day, this took up the bulk of the time. Mr. W. pointed out that the kids were really fried – summer was just around the corner.

Mr. W stayed just long enough to greet the students as they entered the room and then they were mine. Well, not exactly. A Special Ed teacher entered the room to assist and keep order because the class was *special*, i. e., a wee bit 'troubled'. As the period went on it became clear that she had established a friendly rapport with a number of the kids, who really liked her and gossiped endlessly but quietly with her.

Once the kids sort of settled down in their seats I took attendance. I gave them my very brief bio, told them of the day's assignment and began to lecture on cycles. Immediately they got up to get their books, began talking, and didn't pay an elementary particle of attention to what I was saying. The noise level crescendoed. Since it was clearly hopeless, I promptly shut up. I erased what little I had drawn on the board and sat down to find errata in the manuscript of my Calculus Book. The students did their thing and I did mine. When 30 minutes had elapsed, I told them I would collect their work in 5 minutes. Suddenly, at least  $\frac{1}{4}$  of the class began to work.

Then I ran the video. At first it had no sound. Mr. W. had told me that I only had to press the play button on controller #1. I had asked him which the Play button was because the labels had been erased by wear. But he forgot to tell me that the sound was controlled by a different machine (which was turned off) with a different controller, and I had not thought to ask. The teacher from the next room came in but didn't know the system and left. It took me about 3 minutes to find the sound.

A few of the kids asked me to rewind but it was obvious they didn't care and simply wanted to be obstructive. I simply ignored them. After all, they had simply ignored me. I turned off the lights and went to the back of the classroom/lab and continued my search for errata. The kids settled down and most watched the film though a few continued gossiping quietly with the Special Ed teacher.

After about 10 minutes something in *The Queen of Trees* caught my attention and I realized that the video showed the cycle of life centered on a fig tree. Parasites of parasites! A eats B. B eats C. C eats A. At home much later I eventually watched it from beginning to end. It is a breathtaking and magnificent video – a marvelous and compelling account of the extraordinary interdependence of life. I had known

nothing about fig trees, their astounding fecundity and central position in the cycle of life. Go FIGure it! Even though I do not particularly like dried figs I will never look at or taste a fig the same way.

After a long, gratifying break between classes the afternoon Geo class filed in. Again I took attendance and gave a brief bio and then asked for a vote. The majority would win. How many wanted me to give a brief lesson on the day's assignments, 1: El Niño and, 2: Contour Maps? Of the 23 students, guess how many wanted my lesson. Did you guess, 1? That boy, sitting in the front row (so he couldn't see that his comrades were voting NO), raised his hand so little it barely reached his navel.

On the board I had drawn a map of house prices in San Mateo and even richer Hillsdale. I intended to contour this to show them that anything could be contoured. But they couldn't care less so I silently handed out the assignment and sat down in search of errata. Several students later came up with no idea of what to do. I was tempted to say, "You didn't want a lesson, so sit down and work it out on your own!" but of course I didn't. I helped anyone who asked.

The irony is that not one of the students suspected or cared that I had such a high level of expertise. Had William Shakespeare been their Sub for a class on Hamlet they would have flagrantly ignored anything he tried to say, and their interaction with him would have been limited to something like "Hey, Sub, give me the answer to #4!"

At last the class and the day ended. What an easy, worthless day.

### **Next Day: Spanish**

Back home a few hours later, I got the call to sub the next day in Spanish at San Mateo High. I debated about it for a few seconds and then said, "What the heck, I'll do it."

When I showed up and saw the assignment my heart sank. The classes were Spanish 6. Fortunately I had two hours to prepare before the first class. I foolishly erased the assignment written on the board in English, never suspecting that the teacher gave the same assignment two days in a row because it was for Spanish 6 sections that met on alternate days. So I laboriously rewrote the assignment on the board – in Spanish. Then a teacher in the next room found a printed version of the assignment and had copies made.

The two hours of prep gave my nerves time to settle. At first I thought, "What use can I possibly be in Spanish 6 given my pigeon Spanish?" Then I espied on the back wall a large poster of Granada, Spain, where I had spent a wonderful sabbatical year, 2007-08. The teacher from the next room pointed out that a large map of Spain was

rolled up in the back of the room. I brought it to the front and thumb tacked it. (The tacks were already in the map).

I thought of the Thanksgiving Luncheon we gave for my Spanish colleagues at the University of Granada back in 2007. Weeks before, I sensed that my colleagues would ask me to say something in Spanish. So, I prepared a speech and rehearsed it over and over until I had it fairly memorized. It was a total fabrication that amounted to a joke my father had told, which I retold in Spanish with complete deadpan. The joke goes as follows...

“Cuando llegamos en España....When we arrived in Spain...we went to a restaurant. The man at the next table had a dish of huge meatballs in a rich, savory sauce. I told the waiter I wanted that dish but he said it was a special order that required at least a month’s advance notice. I made the reservation and appeared the next month. But the meatballs were scrawny and bitter and double the price. I was irate and said to the waiter, ‘Is this how you treat me because I am an American?’ He answered....Lo siento mucho señor.... I am very sorry sir....pero el toro no siempre pierde!.... but the bull does not always lose!”

Only a few of my colleagues caught on immediately but as they explained infectious laughter spread like wildfire. After that everyone was our friend and we were Spaniards, better yet, Granadinos.

I decided I would tell the class this borderline risqué tale and rehearsed it. As the first class piled in I tried a few Spanish words. There was some murmuring but it quickly stopped. I guess they were surprised that I knew as much as I did, which I admitted was quite little.

Students were eager to listen to my spiel. Admittedly, it was a story rather than a lesson, but in speaking as much Spanish as I could I made it something of a lesson. So, the kids were receptive and learned. It was gratifying that my second year of subbing ended on a high note.

What a difference a day makes!

## Year #2 Postscript: The Teaching Gene, the Kids and the System

During the summer I focused on two projects, 1: Finish *The Soul of All Scenery: A History of the Sky in Art*, a book I began working on in 1978 when I became fascinated by how artists portrayed the sky. It was a labor of love. I finally sent it to the printer in the fall of 2014.

Project 2: Read seriously about the Education Empire I have been criticizing so viciously. I preferred to read books by teachers but also read books by the ‘professionals’, the Education Experts, Philosophers, Administrators, and Journalists. A gaping gulf between these two categories of books popped out immediately. To illustrate that gulf I will tell a short story

In May, 2002 I had double heart bypass surgery, which was followed by a complication called Dressler’s Syndrome, an inflammation of the pericardium, the sac around the heart. I was washed out and pretty much useless the whole summer. So, as I vegged I read 32 simple books – mostly biographies and autobiographies. After a number of these a general pattern emerged. The theme of the autobiographies was to solve a problem that the protagonist had to face and conquer. The biographies, by contrast, often had strong strains of pathos – pity poor Wolfgang Mozart who died at 35 (which is a great pity) and was buried in an unmarked grave (which isn’t). I am sure that once Mozart was dead he didn’t care where he was buried.

So it is with books on education. Books by classroom teachers have a sense of immediacy, vibrancy, ego, and reality that is largely absent in books by education ‘experts’. The classroom teacher has to solve real problems and, faced by seemingly inexplicable successes and failures, comes to question his or her actions, motives, and abilities. Education ‘experts’ tend more to spout theories, have agendas, and pontificate, too often with a bias that maintains that with the right pedagogy, everyone can learn anything. With such experts opposite conclusions abound and persist. Here is a brief list of some controversial topics, with advocates and ‘supporting’ statistics on all sides. No legitimate field of knowledge has comparable uncertainty.

1. School Choice – Public, Charter, Magnet, Private, Religious, Home
2. Social Promotion
3. Special Ed vs. Honors Classes
4. Academic Education vs. Vocational Training
5. Lecture-Lab vs. Inquiry-Based Format
6. Certification vs. Experience, Knowledge and Expertise

Here in *Sub Ways*, I have hoped to pursue and find the truth or truths about the miracles of teaching and learning. I have spent much of my life in the trenches of Education and in this, my years of retirement, the time has come for me to organize, enrich, synthesize, and, if necessary, revolutionize my haphazard knowledge but extensive experience.

The sharp contrast between student behavior on Days #27 and #28 set off an alarm bell in my mind that raised two questions. 1: What can account for the enormous difference between good and bad classes? 2: What magic potion or approach can teachers take to transform bad classes into good or great classes?

On two different days [#8 and #27] in two different years subbing for Mr. W I had encountered disrespectful classes. I mentioned that his large desk and front table were overloaded and disheveled. So, while he was a good scientist and most likely a good teacher of good students, I conjecture that he had little management skill to handle poorer students, who realized they could run over him, and that boiled over to the disrespectful way they felt they could handle his Subs. Recall the survey of Day #1, in which the students pointed out that an important factor in a class's treatment of a Sub is how the regular teacher conducts his classes.

I then recalled a paradigm of contrasting class behavior I encountered. As a Professor, I sometimes gave guest lectures to high school students. One summer, around 1995, when I still used a slide projector, I accepted requests to lecture on some topic about the atmosphere in two different summer programs on two consecutive days.

The first day consisted of an assembly of about 150 mostly East Asian honor science students. The students were riveted by the presentation, and many asked or answered brilliant questions, revealing their love and knowledge of science and their insightful thinking.

The next day's class could not have represented a greater contrast. This was the Michael Jordan – Arnold Schwarzenegger Program of “Inner City” kids, which everyone knows, and no one says, means almost entirely Black kids. Their program had academic and nonacademic components, and I kid you not, the kids were paid for their participation. (The honor students were not paid.)

Having some foreknowledge about this audience, I made sure to prepare a simple, highly visual presentation with a few dramatic demos that would illustrate only the most elementary concepts. I was no babe in the woods and was braced for a tough 90 minutes. For example, I would have almost bet my life that a lot of the kids would pile loudly into the back of the room.

And so they did! But I was not braced enough. They burst into the room with a display of deliberate raucousness. The room had 7 narrow rows. At least 5/7<sup>ths</sup> of the kids jostled and crowded their way into the back 2 of the 7 rows. The three lion-tamer teachers were unable to quiet them down and neither was I. So, I had everyone leave the room and file in again, this time more quietly and not into the last two rows.

That was Mistake #2! (Mistake #1 was ever agreeing to meet this group.) What should I have done? I realized it but lacked the spontaneity, the decisiveness, and, yes, the courage. What I should have done was instead of emptying the entire class, empty every kid who had piled into the last two rows. I could have done this most diplomatically, telling everyone that the 90-minutes would be divided into two 45 minute sessions, and then, as soon as those kids were out in the hall, quietly inform the lead teacher to take them away and keep them away. It wouldn't have been an unprecedented move. Morgan Freeman portrayed how Joe Louis Clark, Principal of Eastside High School in Patterson, NJ did it in the film, *Lean on Me*. But I didn't!

So, I reaped the whirlwind. One student was especially disruptive. At least 16 years old, he acted like 11 or 12. He made animal shadow figures on the screen when I attempted to show slides of awesome clouds. Even after I moved him (but didn't REmove him – Mistake #3) he remained disruptive, and enough other kids joined his chorus so that for 40 minutes that I stood there (Mistake #4), silent for more than half the time, I could do almost nothing. Finally, I said, “**You lose,**” and dismissed the whole class. As one young lady left she said, “I really wanted to learn what you were trying to teach. What can I do?” I don't know if I said the right thing, but I said, “**Get out of your surroundings as soon as you can!**” An easy thing for me to say, an honest thing to say, possibly a mean thing to say, but assuredly a very difficult yet essential thing for her to do.

I never again accepted any invitation from an Inner City School Class or Program. Sorry, but I leave that to other worthier souls. And true to form, while I got paid the piddling stipend for teaching the honor program, the administrators of the Inner City Program screwed up their paperwork and failed to pay me. And remember, the raucous ‘Inner City’ kids got paid and the ‘Outer City’ honor students didn't!

Frank McCourt was one of those precious souls who spent years teaching or trying to teach the nonacademic kids of working class parents and more years with occasional classes of ‘Inner City’ kids. McCourt, who made himself famous with *Angela's Ashes*, the Memoir of his early years, described his life as a teacher in various New York City High Schools in his third book, *Teacher Man*. After leaving school at the age

of 14 and then gradually clawing his way up the education and employment ladders, he finally landed an English teaching job at McKee Vocational and Technical High School in Staten Island.

You cannot read a more genial, yet incisive account of teaching kids, many of whom would now almost surely be classified as Special Ed, because the Vocational High Schools they used to be consigned to no longer exist as such. Perhaps the trades they taught also no longer exist in the USA.

McCourt rhapsodized on every trick in the book that the kids used to methodically stonewall teaching of the subject. If discretion is the better part of valor then McCourt was very valorous, indeed. He realized that he had to largely dispense with the normal curriculum and so, taught using stories of his own life's numerous failures and occasional triumphs, ever hoping, and occasionally succeeding in transforming his misery into inspiration.

After 3½ years of admittedly struggling in the dark that struck no chord with his students, he hit upon a gem. He had amassed a collection of letters, presumably written by parents, but in fact composed by the students themselves, offering BS excuses for their inexcusable absences. Instead of dressing the students down, his brainstorm was to tell the class to imagine they were parents and write an excuse for their absent teenage children. What a series of brilliant and original essays he got from them. Apparently, many of the 'dumb' kids could write, after all.

But it was always and ever a constant, relentless uphill battle.

So, after 8 years at McKee, McCourt left and, following another series of career steps and missteps, miraculously landed a job teaching English at Stuyvesant High School, one of the City's, indeed, one of the world's premier high schools. He described the immense gulf between the two worlds of McKee and Stuyvesant. Finally, at last, he could teach English Literature and Creative Writing. He also emphasized that he had the explicit approval of the Chairman of the English Department, who respected him and gave him an open ticket to do as he would. Are you listening, you meddling, counterproductive Education Empire administrator overseers?

McCourt seems to have been a man after my heart. He was a greater maverick and more eloquent than I, but I share with him mistrust and dislike of the Education Empire, its pompous administrators, and waffling but punitive authorities. And, at least early in his career, McCourt used this dislike of the visible authorities – principals – to advantage in the classes to gain, or even yes, curry favor in his students' eyes. This is one of the intangibles in teaching excellence. Any student who sees the teacher as a victim sympathizes with the teacher and

becomes far more receptive and open to learning. I also used that to advantage most of the time in my career. Perhaps it's good to have a mean principal. It's a variant on the good cop, bad cop theme.

McCourt repeatedly jabbed at the Ed Professors who pontificated eloquently about pedagogy but who knew nothing about the classroom and who probably couldn't have survived a week in one or had escaped and did everything they could to forget about their former lives.

I stated from the get-go that *Sub Ways* would be largely anecdotal and I have largely lived up to my promise. But now, permit me to show a single damning statistic to the holy field of pedagogy, namely a history of the SAT (Scholastic Aptitude Test) scores. Given in the junior and senior years of high school, the SAT represents an integral of the nation's primary and secondary education. Figures 16 and 17 on the next pages show how the SAT Math and Verbal scores have evolved in the half century from 1964 to 2014. The two figures display the same data but appear very different because their scales are very different.

The first thing that strikes the eye in Figure 16 is the sharp decrease from 1964 to 1980. Since then, the Math score has largely recovered while the Verbal score continues to sink. By the way, for the decade before the data shown in Figures 16 and 17, 1955-1964, both Math and Verbal scores were almost constant at the relatively high 1964 level.

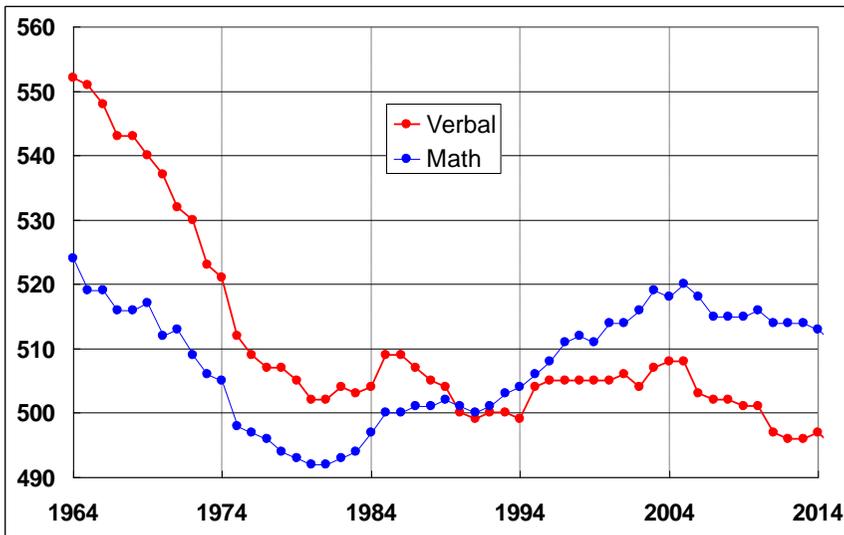
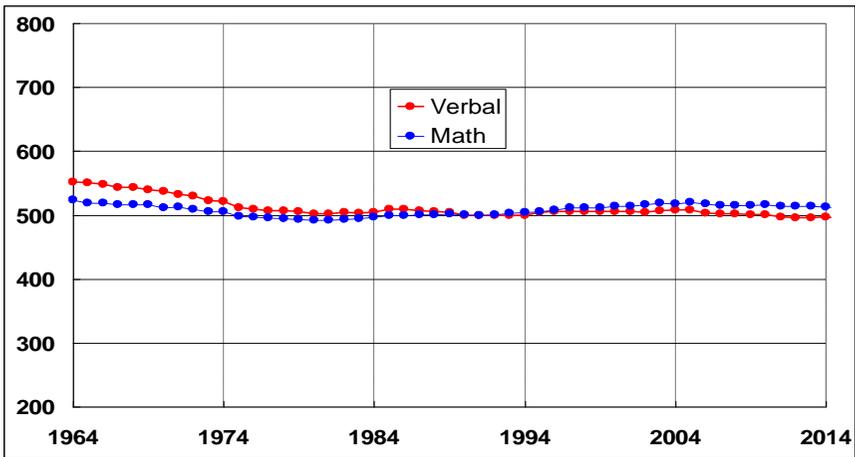


Fig. 16. Math and Verbal SAT scores 1964 to 2014, on a scale from 490-560.

So, the first question to ask is, “Why the decrease? A good part is due to opening the test to a wider audience, particularly Blacks and Hispanics, who, on average score much lower. After the trough in 1980, Math scores rose (Hooray!) while Verbal scores remained just about constant. And in the last decade under *No Child Left Behind*, it seems the Nation’s students have fallen further behind.

The next two questions are related. Why has the Math score rebounded and the Verbal score declined? Two factors should have lifted both scores. 1: In 1980 the College Board began selling old tests directly to students. 2: AP courses have proliferated. Factors that distinguish the changes in Math from Verbal scores include 1: Students today read fewer books, 2: An increasing number of higher math scoring East Asians are taking the SAT, 3: Early PC’s were essentially math programming machines, 4. Qualitative standards for writing and reading have been lowered while quantitative standards for Math are by nature fixed.



**Fig. 17. Math and Verbal SAT scores 1964 to 2014, on a scale from 200-800.**

But before you get too excited about these massive up and down changes, look at Figure 17! It shows the evolution of SAT scores on the full scale from 200 to 800. On this full scale, all changes since 1975 look very small.

So, when you consider all the self-proclaimed ‘advances’ in pedagogy, aided by the proliferation of SAT preparatory courses such as Kaplan and the Princeton Review and AP courses (which do increase scores because they give test-specific procedures and drill the students),

you might be compelled to acknowledge that despite noble efforts, pedagogy has done virtually nothing.

**One grand and perhaps startling conclusion, especially given all the hype about our failing schools, is that students, teachers, and schools are and have long been doing just about as well as they can, and that they are doing reasonably well at that!**

You might respond to such a startling assertion that there are other nations whose schools and students are doing much better. In *The Smartest Kids in the World and How They Got That Way* Amanda Ripley reviews high schools in Finland and South Korea, two countries whose high school students have recently excelled. Both are small, homogeneous societies, which give them enormous advantages over the USA. Finland's solution was brilliant and obvious; hire teachers from the top 1/3 of the academic ladder, pay them high salaries, make the courses and tests demanding (multiple choice tests are almost nonexistent there), require analytic thinking and reasoning, and don't harass effective classroom teachers. (Danielson type rubrics need not apply.)

South Korea's solution was to develop a society of tiger moms and dads who transform their kids into automatons or hamsters on a wheel, send them to interminable after-school programs in hated Hagwons, and make nervous wrecks of the entire high performing student nation. The USA is too cheap and agendized to follow Finland's simple, wise, and expensive path, and both unable and unwilling (except in upscale communities) to follow South Korea's odious, exhausting path.

The attempt to learn takes energy – real, monumental physical energy (more than 20 Watts – recall Day #19), and hence, is exhausting. Attempting to master a difficult or foreign concept or idea or committing to memory a long string of seemingly senseless facts is so difficult that anyone's mind naturally wanders. But when you are motivated to learn by love of a subject, or feel challenged to achieve some strongly desired goal, or are compelled by necessity, or when the learning is inadvertent and connected with some form of entertainment or diversion, your adrenaline gets going and it always feels easier. The secret and elusive techniques to seek out are precisely those that develop any of those positive attitudes. No teacher can hit on them in every lecture, or every class, or with every student, but master teachers aim for and hit more bull's eyes.

I remember all my struggles in school. Do you remember yours? I remember how exhausting it was trying to drill things into my head that simply wouldn't get through my thick skull. Do you? Here, I throw out a challenge. Sit down, and focus on a subject you know you're not good at. I almost guarantee you that your brain will begin to feel fried and you

will quickly find any excuse to stop or to do something else that you like. Then you will be compelled to acknowledge the difficulty of students' lives.

Students have to corral themselves every day, and mostly in a string of different subjects they couldn't care less about. Furthermore, all that time their hormones are prioritizing other things, even if they don't quite know what those things are and what to do about them. Then, if they fail a subject, pile on them the additional shameful, humiliating burden of repeating the same subject, and you have made their lives a misery unless some miraculous and exceptional light clicks on inside them that they need this to get ahead in their lives, or even more miraculous, that the subject is beautiful.

There is little way for teachers to anticipate or tell when they will do or say something that resonate with and turns a student on. It is always a teacher's hope and dream to be able to do this. All I can think of is that teachers must be as alert and sensitive as possible to note when, by some miracle, their words have resonated and then, fan the tender flame they kindled.

I'll illustrate this serendipity with three personal stories. Jacob, the father of one of my daughter's friends, would often pick up his daughter after a play date. Jacob was brilliant – 1600 on the SAT, an MD and a Ph. D. in physics, followed by a career as a software expert in his own company. But try to get a word out of the highly unsocial Jacob and you would fail. Not only was he uncomfortable in our brief social encounters, he made me and many other people uncomfortable. So most of the time I didn't try to magnify my discomfort by attempting to start what would almost surely prove to be an abortive, one-sided conversation.

But one day, I happened to have just finished reading an autobiography by the humorist and political satirist, Art Buchwald. Wow, did he have a tough childhood! His mother spent 35 years in mental institutions and his distraught father, who found himself incapable of raising his children, put them in a series of foster homes. When I told this to Jacob as we were waiting for his daughter to get ready, Jacob suddenly opened up – a complete metamorphosis of character. I got the story of his life. He had also been something of a foundling and as half Japanese and half Jewish, he had suffered monstrously from bullying as a child in Seattle, while his timid parents lived in deliberate denial and were never there to help him.

I had known nothing of Jacob, other than his degrees. Inadvertently, the sympathy I had shown in telling Buchwald's story resonated with Jacob and opened up a normally shut person.

The second story involves my children. At ages 8 and 5 they hated hikes. Upon arriving in Sequoia National Park, they dreaded the inevitable, impending hike. So, I told them that they were not going to *hiKe*, they were going to *hiDe*. I pointed to a fire-hollowed Giant Sequoia. This excited them. What followed was scary for us parents because they hid too well, sprinting from tree to tree in the longest hike of their lives to that point – 6 miles – which they did joyously.

Along the way we came to Tharp's Cabin. I had told my kids and their occasional sleepover friends countless stories, mostly fiction. One of the stories was real – how Hale Tharp, a failed gold prospector, became a shepherd and discovered the noble trees of Sequoia Park when he led his flock to the high country of the Sierra Nevada. There he made cabin out of a hollowed, fallen Sequoia. When we reached Tharp's Cabin Evan's eyes almost popped out of his head. He couldn't believe that the story I had told was real. And the revelation that the story was real helped my kids remember that encounter and that day in Sequoia Park for years.

The third story occurred on the first day of the semester in my hydrology class. I wanted to illustrate how much water we waste. The room had a deep laboratory sink, into which I had secretly placed a 5 gallon pail before class. Without introducing myself, (though a number of the students knew me) I apologized to everyone that I had neglected to brush my teeth before class. I turned on the water, and proceeded to brush my teeth for exactly 60 seconds. The entire class of captive prisoner students thought it was disgusting. When I finished brushing my teeth and turned off the water I hauled up the 5-gallon pail, now more than half full and calculated how much precious water we 300+ million Americans senselessly waste.

Months later, several students told me how much that simple demonstration had affected them. One student said that it made a greater impact on her than all the math and lab exercises in the rest of the course. I did it to be dramatic, but had no idea its impact would be so indelible. I had essentially told a surprise story that metamorphosed from a scene of a disgusting slob to a drama of a compelling truth of needless waste on a fresh water starved planet.

Many of the best lessons embed learning in stories. The best speeches contain 95% old material that we know. That makes us feel smart and sets us up for the 5% new material. So teachers...make it fun, fun, fun – if you can! The paradox is that games and stories can set us up to do the hard work we would have otherwise avoided.

I don't know how good a teacher Frank McCourt was. I have only his book and the testimony of a few carefully selected students. He certainly

seems to have been quite good. And early on, he recognized that his stories about his rough, failure-ridden life had something to do with it. Oh, yes, his vocational (now Special Ed) students had their fine-tuned radars on to detect any switch from a story to the required subject material, and used every evasive tactic in their repertoire to avoid the switch. Then he struck something as close to the mother lode as possible when he had them write absence excuses for their 'children'. That was inadvertent learning. That made it fun.

It's always a delicate balance between fun and work (as Tom Sawyer discovered) but the balance is less delicate for the poor students who try to avoid all academic learning at all costs.

The techniques of grabbing attention and interest for a lesson have not escaped the experts of the Education Empire. They even have a 'fun' name for it – the *Anticipatory Set* – which they further dehumanize as the *hook*. Of course, they formalize the technique to the hilt and thereby drain its joyous lifeblood. And here is another irony. The term *Anticipatory Set* was coined by Madeline Cheek Hunter who insisted that a student must never be put down while confessing ironically that precisely what inspired her to become an educator was being called dumb in a 7<sup>th</sup> grade assembly. [<http://www.cultofpedagogy.com/>]

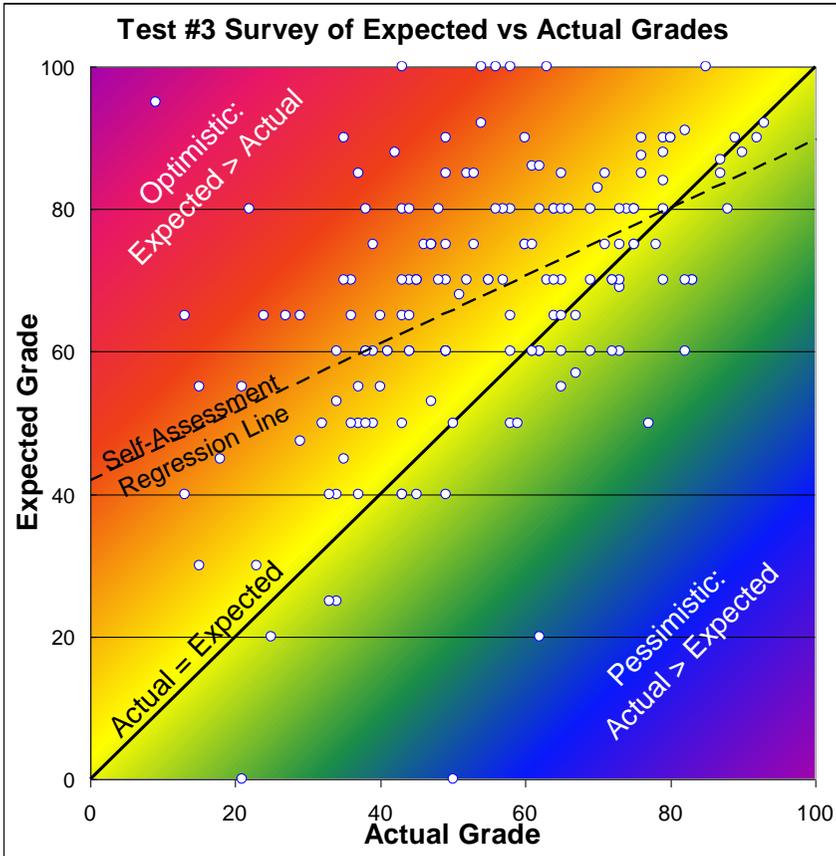
Take away the strait-jacketed mandate of the Education Empire's Pedagogy Bureau and replace the fancy lingo, *Anticipatory Set*, with its synonym, *Introduction*, and some of the magical allure of this remarkable educational 'innovation' evaporates into its ancient and eternal form. You don't need a battery of Ed courses and an overseeing administrator to know to begin a play, a story, a book, a speech, a court summary, or a lesson with an intriguing introduction.

What do you think is the Education Empire's fancy lingo for summary and conclusion? You know they have one. But, prepare to be disappointed. It is...*Closure*! A common word, plagiarized because of its media allure from the psychology of dealing with tragic loss.

Continuing the topic of lingo, *Metacognition* is another beautiful term promenading around the Pedestal of Pedagogy. Meta comes from the Greek for after or beyond. Therefore, it is pasted in front of many words to aggrandize their meaning and generalize their import. Meta is a prefix that terrorizes me because I know that not only is it beyond me, it will not enable me to solve a single new problem. For example, you can solve many problems using Physics. I don't know of a single problem ever solved using Metaphysics.

In any case, Metacognition means knowing or being aware of how you think, of what you know, and of what you don't know. Indeed, it is essential for a person who does not know or understand something to

realize that they do not know or understand it. If you don't realize your ignorance you never learn. So, if teachers can make students become aware that they do not understand something, it should be possible to increase their learning. By the way, if it is difficult to teach any subject (and it is), it's consummately difficult to teach self awareness. Just look at politics!



**Fig. 18.** Expected vs. Actual Grades on the 3<sup>rd</sup> essay and problem-solving test in a Climate Change Course. Results are typical.

With that idea in mind, in the Fall Semester of 2001, I began to ask students to estimate their grade on their tests both right after they finished the test and about a week later (before the test grades were returned). The results, shown in Figure 18, startled me but were similar to what other researchers had found. Students with high grades (above about 80%) tended to underrate themselves while students with low grades tended to overrate themselves. On average, the lower the grade a

student got on a test the more they overrated themselves – to the point on short essay and problem tests that a student whose actual grade was 0% expected to get 40%! This happened in test after test and class after class. On multiple-choice tests, students with low grades overrated themselves even more egregiously. Only on tests where students wrote computer programs did they routinely underrate their scores. When a program failed to run the downcast students assumed they had totally screwed up even if it was a minor syntax error, such as using a comma instead of a colon that kept the program from running. But in that case, the computer, not the teacher, told them an answer was wrong and the computer is God.

Perhaps the most important questions about the surveys are, did they improve the students' 1: accuracy of self appraisal and, 2: grades on subsequent tests? In almost all semesters, the accuracy of self appraisal did not improve from the first to the third test. One semester, in an attempt to encourage self-appraising accuracy, I told the students I would add 5% to their grade on any test whose estimate came within 3 points of the actual score. This had no impact on the accuracy or bias of self-appraisal.

Test scores of students who took all three tests in a semester did improve on average, but only because the students realized they had to 1: study more, 2: focus attention on the sample questions, 3: come to my office in the days before the tests to review their thinking and answers.

The students who came to my office to attempt to answer the sample questions averaged over 20 points higher on the tests than those who didn't. Of course, no sooner did I announce this disparity than the goof-offs piled in my office expecting me to spin straw into gold, and the statistics were corrupted.

Through conversations and interactions with many students I came to realize one profound source of bias in people's self-assessment of their knowledge and understanding. Many people confuse and equate the ability to rattle off the name with knowledge and understanding of a concept, process, or phenomenon. This is called the *Fluency Illusion*. For example, many students merely familiar with the term, Atmospheric Greenhouse Effect assumed that this meant they knew what it is and what makes it work. Upon receiving a low grade on the question, they were prone to argue for more credit and worse, continued to firmly believe that they understood it since they knew the term. In retrospect, this is not surprising. The Fluency Illusion is exceedingly difficult to dispel. It is part of the human condition.

After all, isn't the whole human race gulled and lured by the notion that magicians can cast spells through magic mumblings of secret, strange-sounding words such as Abracadabra (a sort of ABCD). Words

have great power indeed, but incantation does not equal understanding, lacks motive force, and cannot create anything. “In the beginning was the Word,” even using the broader translation of Logos, may be tempting, but is wrong. So often, when we are wrong, we fail repeatedly to see the facts. Sorry, *Harry Potter* fans, there are no magic words and there is no magic wand. There is no Royal Road to Reality.

Those who lack self-awareness are also likely to lack the Teaching Gene (and the closely related Introspection Gene – if I may so call them). Surely, there is a Teaching Gene, though, as with Cassandra whose ability to tell the future was not believed, it is neither recognized nor possessed by most. Olga, a Grad student at the University of Granada during my sabbatical year, was friendly and tried to communicate with me. But she couldn’t slow down her rapid-fire speech in Spanish one bit, even after I repeatedly asked her to do so and let her know I couldn’t understand when she spoke rapidly. One day, she was in my office firing away when the cleaning lady (pardon me – whose name I sadly forget) walked in. The cleaning lady quickly sized up the situation and told Olga to speak more slowly because I couldn’t understand. The cleaning lady had the teaching gene and the graduate student didn’t!

Those who lack the teaching gene suffer from a form of amnesia regarding the problems they experienced mastering a subject, and great impatience for others having the same problems they forgot they had. Many of them can give a good talk or summary in their areas of expertise. But when they face someone who has less than complete and immediate understanding or who asks a question seemingly out of left field, or perhaps any question at all, they become impatient, frustrated, and often gruff, and do not know how to handle it, other than to quickly repeat verbatim some excerpt or even the entirety of what they had just said, and then remark that this is what they had just said. Students who are bright, self-motivated, and inspired can make do with a knowledgeable lecturer who lacks the teaching gene, but poorer students will flounder under such teachers.

The teaching gene is, of course, only a starting point. Teaching knowledge or expertise, and sensitivity to where the students are, can be developed to reach or approach the automatic mode. This happened to me as a lifeguard. The first kid I saw in trouble was struggling silently at the opposite end of the pool no more than a foot from the side ladder. As I sat there wondering if he were in trouble two of the experienced guards dove right over me and rescued him. I never missed another.

By my third summer as a lifeguard I got so good I could distinguish the one thrashing kid in trouble from a pool full of kids thrashing around

with their faces in the water and having fun. The difference is subtle, but I got to know it in my gut. That sensitivity is what a master teacher has.

During one of those summers as a lifeguard, I was walking in town and had just passed a bar. I stopped at the corner as a police car drove up. The policemen in the car looked unconcerned as they approached the corner, but the one riding shotgun suddenly became alert as he looked right through me toward the bar. Both jumped out of the car and subdued a man who had come from the bar holding a knife behind his back. The initial lack of concern in the policemen's appearance and posture told me that they had not been forewarned of trouble, but that they had developed an instinctual and immediate recognition of it. Given my lifeguard expertise, my respect for the developed talents of the police went up many notches at that moment and has never come down. It's good at this point to quote Frank McCourt.

“Find out what you love and do it. That's what it boils down to. I admit I didn't always love teaching. I was out of my depth. You're on your own in the classroom...and you have to find ways of saving your own life. They may like you, they may even love you, but it is the business of the young to push the old off the planet....You can be knocked out or gored....But if you hang on you learn the tricks.

The classroom is a place of high drama. You'll never know what you've done to, or for, the hundreds coming and going....After a few years, you develop antennae. You can tell when you've reached them or alienated them. It's chemistry. It's psychology. It's animal instinct....Don't expect help from the people who've escaped the classroom, the higher-ups. They're busy going to lunch and thinking higher thoughts. It's you and the kids.”

Since I have mentioned and quoted Frank McCourt so much, you might be interested to know what he said about his experience as a Sub when he was forced to Sub while waiting for a permanent position during one of the many interludes in his erratic teaching career.

“I became an itinerant substitute teacher, drifting from school to school....I was assigned classes in English or wherever a teacher was needed: biology, art, physics, history, mathematics.

In the classroom I had no authority....Students paid no attention and there was nothing I could do. The ones who came to class ignored me and chatted, asked for the pass, rested their heads

on desks and dozed, floated paper airplanes, studied for other subjects.

I learned how to discourage them from coming to class at all: If you want an empty classroom all you have to do is stand at the classroom door and scowl....Everyone in school knew the rule: When you see a substitute teacher, run, baby, run.

Reading that quote makes me feel I'm doing pretty good as a Sub!

### **Year #3: Day #29: Rebel With a Cause: The Lion in Daniel's Den**

Perhaps I'm not doing so good as a Sub! My assignment for the day, in all five classes, was to show the movie, *Rebel Without a Cause*, and not from the start but from some different random place each class had left off the day before. Despite this I felt a sense of excitement that surprised me. Scrape the veneer of nervousness and you may find excitement below. In any case, it shows that I am happy to be back in the school environment.

My survey for the day was risky, "What do you hate most about school, not including teachers, and how would you change it?" Aside from a few complaints about doing a survey, most of the students took this question seriously. The overwhelming response was that there was far too much homework. A fair fraction of the students who made this comment added that the homework was often mindless make work. The second most common response was that school started too early and that they were always tired. Some students linked the excess of homework and the deficit of sleep.

This simple survey confirmed a general truth – namely, that young bodies need the extra sleep and are often on a later schedule. This makes it logical that school times coincide with and not precede normal work times, except possibly for team sports that require morning workouts.

The students' hatred of homework is echoed by Alfie Cohen in *The Homework Myth: Why Our Kids Get Too Much of a Bad Thing*. Cohen's assertion that most homework has little value may hold true for mindlessly repetitive exercises, but denying the value of good homework is like denying the value of practice in any field.

My only documented statistical result as a professor regarding the value of homework came from Hydrology. The one semester that I did not require the students to hand in the problem sets had the worst test grades of the ten times I taught the course, even though we did part of every lab in class and even though I posted the solutions to all the labs. That semester the test scores averaged 0.93, 1.60, and 2.46 standard deviations below the mean of the other semesters for Tests #1, #2, and #3 respectively. Thus the impact of not doing homework appeared to be cumulative especially given that when the students were told they didn't have to do it, they probably didn't, but only looked at the posted solutions. Even in the semesters that I didn't grade and return the problem sets on a timely basis but still collected them and issued dire warnings about the severe penalty for missing even one, the students performed much better!

In a related, personal anecdote, when I was an undergraduate senior I took a Physics course my friend, Ricky Tropp took the year before. Ricky had done all the problems and assembled them in a manual. I tried each problem on my own until I either solved it or until it was clear that there was some ‘trick’ I had missed and would continue to miss. Then and only then did I look at Ricky’s solution manual. The moment I saw the ‘trick’ after my labors, I understood what to do and what I did wrong or missed. It was clear to me that if I had not struggled, not only would I have failed to get the ‘trick’ I would have failed to learn the problem. Easy come, easy go.

In two of the classes, especially the first slow English class I thought to ignore the teacher's instructions and not show the movie at all. I wanted to get a conversation going about where the students are going considering that they hate school. But I didn't and more or less followed orders. I don't know if anything good would have occurred but I ensured that nothing would by not taking the chance.

This raises the question: How important is it to go with your impressions or brainstorm as a teacher or as a Sub?

Ten days later, I went to introduce myself to the English Teacher, something I had done with a number of the teachers I had subbed for. Call him Daniel. He was livid at how I had conducted his class. He claims that I had set him 15 minutes back (an exaggeration) – he had to show more of the movie than he wanted when he returned. He wanted a Sub to follow his orders exactly – no improvisation. He took umbrage at my survey, my introduction, my disobedience, my gall. Ironic that a man who showed his class *Rebel Without a Cause* was a man who took extreme umbrage at any hint of rebellion. He clearly hadn't internalized the movie's message. It got me down but we left our less than 1 minute encounter with clarity. He wouldn't want to use me as a Sub again and I wouldn't want to Sub for him again. I don't think that I would have wanted him as a teacher had I been a student. I haven't seen him in class, but I think literature is supposed to liberalize you, not rigidify you.

It also made me think, “What if a Sub annoyed 29 out of 30 students but reached a single student that the regular teacher hadn't or couldn't?” That wouldn't harm the 29 but it would help the 1. There would be a net gain even with the trivial loss of time.

## Day #30: Chemistry with a bit of Physics: The Order of the Sciences

I got the call at 5:00 AM. I'm always scared to sub in Chemistry. But Chemistry hinges on Physics and I know enough Physics to be helpful. So, I can always provide some useful or at least interesting information. I had two last minute ideas. I put a graph on the board (Figure 19) that showed the logical order in which the various sciences should be learned, and then said,

“Every science starts with observations and measurements. Math is needed to do physics, which is the first science because it treats the simplest, most fundamental situations. The derived, interdisciplinary sciences, such as astronomy come last.

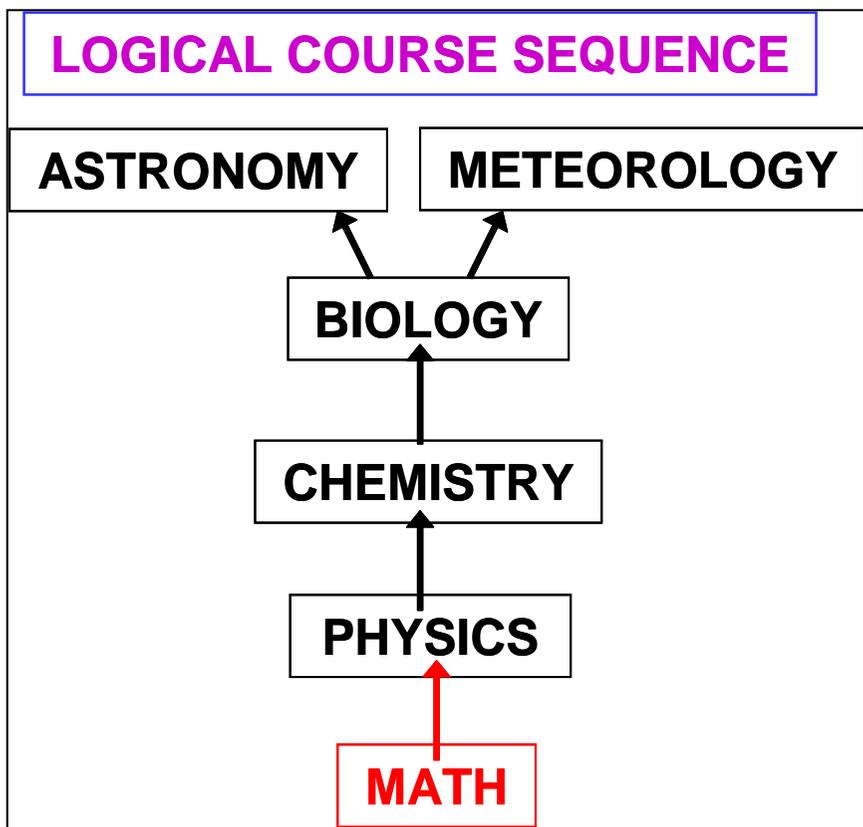


Fig. 19. Logical order of presentation for the sciences. For the natural order of presentation, reverse the direction of the arrows.

The Natural Order of Presentation is the opposite of the Logical Order, because we begin life with eyes but without the advanced math that was developed in large part to solve problems of Physics and Finance). The more observational sciences, such as meteorology, astronomy, geology, zoology, and botany involve the phenomena such as clouds, storms, stars, minerals and gems, animals, and flowers that we can identify with, be awestruck by, and love without understanding. That is why these are the sciences that are linked to ancient mythologies and religions. It is from the observations of these phenomena that we humans naturally learn to classify and ultimately, find general laws of the more abstract sciences.

Want an example of how Physics underlies Chemistry? Then, tell me how Helium got its name!"

Several students were able to answer, "From Helios, the Greek Sun God." But none could answer why the Sun was involved.

Subs almost never have access to the computer in class. This was just about the only time the teacher gave me access. I downloaded and projected an image of a spectrum emerging from a prism and spoke about wavelengths and colors. Then I projected a picture of spectral lines for various elements.

"When sunlight passes through a prism and a magnifying glass, its spectrum spreads so wide that some specific colors show up as bright lines. Robert Bunsen, the chemist of Bunsen burner fame, noticed that one yellow line matched that of burning Sodium. That was the key that let the chemists go to town. They linked many lines to known elements. But there were some lines they couldn't match. One was the yellow line of Helium. So, Helium was discovered on the Sun before it was found on Earth.

The beauty of using optics for chemical identification is that you can do it from 93 million miles away. You never have to touch or inhale the chemical. Too many chemists worked with poisons and died young. Now we use optical techniques to analyze our blood for any pathogens."

I then played the video of Tom Lehrer's song, *The Elements*, in which he names every one of the first 103 elements to the tune of Gilbert and Sullivan's "I am the very model of a modern major general" in under a minute. It got a good response, particularly from the AP students. Many students loved his mocking end, namely the ancient Greek version of the elements, "There's Earth and Air and Fire and Water." Several years earlier I gave my brother, Robert a CD of Lehrer's songs. Robert played *The Elements* for his Special Ed Chemistry classes. He told me that his students had absolutely no reaction to or understanding of it.

In Physics class, the last period of the day, the topics involved density and pressure. The students entered the class noisy and remained noisy. I had to quiet them several times and the quiet attentive interludes never lasted very long. I finally got their attention by placing a paper clip in my open palm and swinging my arm around like a windmill. The clip stayed in my hand even when my palm pointed down because my hand accelerated downward faster than gravity (like some Amusement Park rides).

To illustrate density (and hold their attention), I took out a candle and matches from my emergency kit. I lit the candle, held its base in one hand and turned it in all directions, showing that the flame always points upward. I held my other hand directly below the flame. As the melted wax dripped onto that hand and seemed to burn it, I writhed in mock agony. That did grab the class's attention (and always did even with my college students)! Then the question: "Why does the flame always point up?" A student said, "Because heat rises." "Close! It is not heat that rises but hot air. The flame heats the air which expands, gets light and rises. And that is why hot air balloons rise and why the rising hot air quickly burns your hand when you place it just above a flame. It is also why your hand barely feels hot when you place it below a flame."

With their attention briefly fixed, I asked them to breathe on their hands with open mouths and asked how it felt. (Hot!) Then I asked them to blow on their hands with lips compressed. (It felt much cooler!) Why? It was time for a round-about explanation. To begin, I showed visible and infrared satellite photos of Hurricane Guzman as it headed north from Puerto Rico. "The satellite "sees" the cloud tops. Infrared satellite images are really temperature maps. The temperature at the top of Hurricane Guzman's clouds is about  $-70^{\circ}\text{C}$ . Why so cold? When you blew with compressed lips, temperature of the escaping air decreased as pressure decreased. If even tropical air rises high enough pressure will decrease enough to cool it to  $-70^{\circ}\text{C}$ !"

But what is pressure? To illustrate pressure, I had a girl put her hand on her desk and I put my hand on top of hers and pressed down. She screamed in mock pain. When asked why, she and the class recognized it was the pressure. I had her place her other hand on top of mine. No pressure, so no pain. So air at the bottom of the atmosphere feels much pressure but as it rises the pressure on it decreases, so its temperature also decreases. And when temperature decreases enough dry, invisible water vapor can condense to make visible clouds and rain. I decided not to tell the class I have flown into several hurricanes.

I followed this with a more dramatic demonstration of the nature of pressure. I placed a heavy text on the girl's outstretched palm. I asked

her if it hurt. "Of course not," she said. Next, I gently lay a sharpened pencil on top of the book. She couldn't feel any difference. Then, I took the book off her hand, gently placed the pencil with the sharpened point facing down on her palm and slowly moved the book as if to rest it on the pencil eraser. The girl cringed in anticipation of the pain. Everyone recognized that it would hurt and that the pencil point might even puncture the skin of her hand. Why? "Pressure is force divided by area and when you divide by a tiny area or number the result is enormous."

This ended my teaching day on a high note. But there was one more teeny part to the day. When I arrived in the Office to return the keys and the Attendance sheets for the day, the Administrative Assistant told me that the AP (Assistant Principal) wanted to meet me.

Wow! That was new! No school official had ever wanted to meet me before. Was it possible that word had gotten around that I was actually an interesting Sub?

If you thought that, you are as deluded as I was. The AP wanted to see me to inform me that it is illegal to conduct surveys. That was a new one on me. So I promised not to conduct surveys in Aragon. (But there is still San Mateo and Hillsdale Highs.) He agreed that the restrictions might stifle creativity but he must enforce the law. He also started to warn me about photographing the students but that one I already knew and told him that I only photograph clouds. The interrogation ended pleasantly enough. Stupid, stupid, stupid system! Do we stop conducting medical experiments because of some abominations by Nazis?

### Day #31: Can You Afford Your House and Your Life? When the Eyes Open

Lord help me, I hope that I don't offend the teacher I sub for today. I took 20 minutes out of each of 3 block schedule math classes, asking them to estimate how much income a family of 4 would need if they purchased a \$1,000,000 home without a down payment with a 30 year mortgage at 5% and had to pay California's annual real estate tax of 1% of the purchase price.

The results were mixed. Even though the students were mostly involved and interested in the problem, the lack of specific rules, procedures, and equations troubled them. They recognized that it made them think differently.

Let's analyze the income needed for the \$1,000,000 house. The problem is not as well posed or as narrowly defined as typical school math problems such as, "If 2 sides of a right triangle have lengths 3 and 4, find the length of the hypotenuse using the Pythagorean Theorem." Or, "If the sine of an angle is 0.5, find the angle."

The income problem does not have an exact answer. The approach requires a mix of estimates and calculations. Let's start with the mortgage calculations. First is the annual interest on a \$1,000,000 mortgage. Five percent of one million dollars is...

$$I = \frac{5}{100} \times \$1,000,000 = \$50,000$$

The principal has to be paid over a period of 30 years. In equation form the annual principal payment,  $P$ , averages,

$$P = \frac{\$1,000,000}{30} = \$33,333 \approx \$33,000$$

The estimated total annual mortgage payment is \$83,000. But this estimate is too high because as time goes on the remaining principal (and resulting interest) decrease. The accurate mortgage formula, which the students did not know, gives about \$65,000 per year for interest and principal.

Then there is the 1% CA real estate tax.

$$\text{CAL TAX} = \frac{1}{100} \times \$1,000,000 = \$10,000$$

Adding this to the \$65,000 mortgage payment shows that before any living expenses and any income tax the annual house cost is \$75,000.

Next are the living expenses. A car costs about \$5000 per year to run including insurance, gas, repairs, tolls, etc., but not including the purchase price. An upscale family in San Mateo would almost surely have at least 2 cars. Then there is food. It probably costs at least \$10 per day per person or \$40 per day per family of four. Multiply this by 350 days per year that you eat at home yields,

$$F = \$10 \times 4 \times 350 \approx \$14,000$$

Other expenses include home furnishings, home insurance, medical insurance, life insurance, education, vacations, clothes, entertainment, utilities (phone, internet, TV, electric, and gas), grounds keeping, repairs, and medical expenses. Add all these things and you get about \$100,000 for living expenses. Of course you can get by on less but most people who live in \$1,000,000 homes do not eat only rice. And we haven't included saving for retirement and for college.

So far we have \$175,000 of house and living expenses. Next, include the taxes. Federal income tax is about 30% in this bracket. California state income tax is 12% and Social Security tax plus Medicare tax is about 8% unless you are self employed, in which case it is almost double. Therefore total tax rate is 50% of the total income. The expenses are therefore the other 50%. So each 50% or each half is \$175,000 so the total income needed is \$350,000.

You can certainly live cheaper and save some money. The US government gives credit for mortgage interest, real estate tax and state income tax, so the Federal Income tax rate will be lower than 30%. Perhaps this will save you \$50,000. But life in the fast lane is incredibly costly.

**How did the students do?** Most of their work was characterized by disorder. A few calculations were presented, seldom in complete equation form. For example, annual interest or principle payments may have been calculated but were not often stated clearly.

Many students don't know what a mortgage is. They don't know that interest is charged on the principal of the loan. They can't make coherent estimates. Work is presented as chicken scrawl. Some estimates are on target or at least have the correct order of magnitude. Others don't. For example several estimated that the annual food bill for a family of 4 is \$1000. That is \$0.75 per day per person. All they had to do to realize such an estimate is way off is to think about the \$5.00+ ice cream cones or mochachinos they buy in the local upscale shops.

After they handed in their estimates, we returned to the subject of the day. In the spirit of attempting to add something to each class, I mentioned the tale that Descartes' inspiration for Cartesian Geometry came from watching a fly cross a tiled ceiling. In the Calculus class I showed how to add vectors head to tail. And in Statistics, since they had learned the normal distribution, I showed them how unlikely it was to get more than 75 heads out of 100 tosses of a fair coin – 5 standard deviations above the mean (recall Figure 7 from Day #9).

But the encounter with the English teacher I had subbed for ten days earlier and the subsequent meeting with the Assistant Principal had taken much wind out of my sails. So in the last class I simply gave them their exercise, and let them go to town without introducing myself.

But I was not anonymous. One girl who had eyed me silently in one of the English classes on Day #29 was having trouble with the exercise in geometry on similarity and proportions. She appeared to hold some hope I could magically open her eyes. She told me she had been able to do Algebra but that Geometry was a mystery. She had fallen behind and was too embarrassed to ask questions of her regular teacher.

So, here was a rare opportunity because almost complete anonymity is another of the Sub's few trump cards. We worked together for about 10-15 minutes. In that short time I could neither think of a way to convey the concepts to her nor get her off her dislike and fear of the subject. In the end she used me to not only confirm but reinforce her negative attitude. I felt terrible. As a Sub I would not get another chance.

Later that day I spoke about the girl's problem to my mother. She remembered the moment the window of understanding opened for her in geometry. Prior to that, Geometry had been incomprehensible to her. After that it was a piece of cake. [Opening of the eyes is one of the great experiences of school and glories of life.]

## **Days #32-33: The Beauty of Outside Expertise: The Pun Pundit**

I got the call to sub two consecutive days in Math and Computer Science. The first period each day was Comp Sci. Two young men from a Silicon Valley Company walked in a few minutes after I did. They informed me of the arrangement. They were teaching the course with the approval of their company and the school. The regular math teacher normally sat in on the course to learn the material so that he might eventually teach it. Besides, a teacher legally had to be present at all times (regardless of whether he would ever teach the course in the future) because the computer scientists were not licensed to be alone in a class with students. That is why I was there – I had the license they lacked to be alone with students in a classroom.

So, I had nothing to do but to sit and admire what the computer scientists were doing. On the first day they gave a test and on the second day they reviewed the answers. The course was programming in the C language. The topics were Loops and If statements. Loops contain repetitive instructions or calculations that computers do extremely rapidly. All computer animations are done using loops in which objects are erased and redrawn in slightly new positions and/or shapes and/or colors. “If” statements involve decisions the program is instructed to make when there are two or more choices. For example, a ball that is moving to the right will continue to do so *if* it doesn’t hit a wall. Then, it will either bounce off the wall and move to the left, stick to the wall, break the wall, or magically move through the wall as if it weren’t there (as in movies with Ghosts). In a climate or weather program, ice or snow will only melt *if* the temperature rises above freezing. In Economics, an item won’t sell *if* its price is too high.

The two young computer scientists were clearly experienced programmers. They did a marvelous job of teaching, with great enthusiasm and energy, and the way they worked together was a model of team teaching. Neither had ever taken an Ed course!!!! Amazing! So, how in the world did they do it? (Of course, I’m being facetious!)

The idea to use outside professionals as a component of high school education is excellent. I would advocate that a fraction of teachers be successful professionals from the outside world – doctors, dentists, lawyers, engineers, computer scientists, artists, musicians, authors, mechanics, business executives, etc. Surely observe and assist them as they encounter the student armies but 1: Do not even ask if they have taken any Ed courses and 2: Have them teach electives and allow them to expel any student who causes trouble or does not perform.

In the afternoon math class I gave the “How much must you earn to afford a million dollar house” question again. One student with glazed eyes looked as if he were drugged or exhausted, and silently and steadfastly refused to do anything. I was worried for his health and was tempted to call the nurse, but he lit up when a girl he liked came in, showing he was not at risk of dying. Still, he did nothing. I left him alone.

A bright student asked in a challenging manner and voice whether my question came from his teacher.

“No, *its mine*”, I responded quite candidly.

“Why are you giving it to us?” I could see that mixed with his challenge was a serious desire to know. He had every right to ask that question. That’s what education is all about. I gladly elaborated on the spiel I had given to so many other classes.

“I know it’s not the typical problem you get in any math class. It’s a difficult and weird problem because you haven’t been given a specific equation or a specific method. But it is a math problem and a very important one, because it can save your financial life. If you can’t solve it after 12 years of math in school, then maybe math hasn’t done you some of the good it should have done. Just think of the 7,000,000 people who lost their homes because they couldn’t calculate how much they could afford. If my silly problem saves one of you financial hardship later in life I will have more than earned my keep.”

[Much belated afterthought: I wish I could have referenced Dr. Ben Carson’s 2014 book, *One Nation*, in which he advocates knowledge of financial aspects of math (budget, interest, credit) as 3 of 9 basic requirements of an effective education.]

You never know how people will react, but as I answered, I could see that he and several others were thinking. They appreciated that I responded to him as one adult to another, and were satisfied with both my answer and intent.

As I walked around the room answering Calculus questions a girl asked me if I were the Sub who had dueled with her in punning the year before. Then I recognized her. Call her P.

One day the previous year I had made several puns in the first class of the day. I routinely make puns. But the enthusiastic class response surprised me. One student spoke up. “You should meet P! She can out-pun anyone!” Everyone agreed. As usual, word got to P through the grapevine, so that when she walked into class several periods later she was ready and eager to duel. And in true pun form, the way to win such a contest is to think *rabidly* without appearing *punsive*. She was fantastic – a *wordthy* adversary. The class absolutely loved our little contest.

So, here she was again, this brilliant, witty, beautiful, punning young lady of Indian descent (probably from the PUNjab). Her reputation had grown and had spread far and wide in San Mateo High. She had pursued, developed and promoted her punning talent to the point where she ran Punday Monday on the school's intercom. She gave me a stream of the lawyer puns she had both looked up and thought up for that week's offering. I was speechless except in praise. She clearly has a punderful life ahead.

## Day #34: Social Studies Super Sub: Teaching History Brilliantly is Tough

I subbed for this messy Social Studies teacher back on Day #2. As I entered the room, I was confounded and awestruck by magnificent notes on the board outlining the history and content of Economics. They were not left by the messy teacher but by someone I crown and mitre, Super Sub. No way could I ever have written those notes. They were impeccably organized, and displayed detailed, incisive knowledge of Economics. I asked the students how the lesson had been. One student said that they learned more in that one day than their teacher had taught them all year. I asked the rest of the class if they agreed, and they did. Then one student defended the regular teacher as a nice person but when I said that wasn't my question, she acknowledged that the teacher wasn't so good and the class reaction showed this to be a gross understatement.

One of the assignments dealt with Zionism and problems in the Middle East. So, I gave two simple survey questions, and show the votes alongside each opinion.

### 1. Who is more justified?

Israel	6
Palestine	7
Neither	13

### 2. Who are you rooting for in the World Series?

SF	24
KC	1
Neither	2

I think you can conclude from this that the students in San Mateo care a bit more about how the San Francisco Giants would fare in the World Series than about Middle East politics. But the San Mateo students were aware that while students in the Middle East wouldn't care about which team won the World Series they sure do care about the outcome of their peoples. And in Israel and Palestine just about everyone would vote that their side is right, just as almost everyone in SF voted for the Giants and just about everyone in KC would root for the Royals. I used that as an example of bias, comparing religious fanatics to baseball fans. I asked the origin of the word, fan and one student said it was short for fanatic.

I then gave a brief history of Zionism, beginning with the Dreyfus Case. It went like this...

“Modern Zionism began with the Dreyfus case around 1900. Alfred Dreyfus was a Jewish officer in the French Army. Accused of being a

traitor on trumped up evidence, he was quickly convicted. Theodore Herzl, a Jewish reporter who had favored assimilation, concluded from this case that all attempts by Jews to be accepted by mainstream Christian Europeans had not only failed but would always fail. In other words, "There is no sense trying to get on their good side". In good part as a result of Herzl's incessant lobbying, a generation later at the end of World War I, England and France granted a homeland for Jews in Palestine, a small section of the Turkish Ottoman Empire they had dismantled. When European Jews emigrated to Palestine to escape Pogroms and worse, it led to inevitable conflicts with Arabs, who considered the land their own."

Regarding my little lectures, I have reached the point where if they hold the class's attention I continue, but if there are disruptive side conversations that won't stop, I simply stop talking. At such times I have realized that, "There is no sense trying to get on their good side". After all, in most cases that a few students are disruptive not a single student will rise to call the disruptive classmates to task – neither will a single student ask me to continue. (Such passivity also allows bullying.)

But this time the attention of the class was riveted, even though my brief lecture lacked the coherence and eloquence it might have had with time to prepare. I asked myself why and it occurred to me, given their positive reaction to Super Sub and their almost unanimous opinion that their regular teacher is not good that they paid attention because they felt they were being cheated by learning so little from their regular teacher and were hungry to learn something.

I mean that seriously. Consider K. Sophie Stallman's memoir of her newfound motivation to learn after the Nazis invaded her homeland, Poland in 1939.

Before the war...I imitated [my older sister] Ann's "cool" way of moving through school with a minimum amount of study....Now, with the Germans forbidding any academic education, nobody had to explain to me that our enemies wanted us Poles to stay uneducated and ignorant. I got the message quickly and must have said my typical, "Oh yeah? Try me!"

I realized that, although I did not know where I was going or what life would be like after the war, this was my life. Every day started to count. At 13 years old, I started sponging up all the knowledge I could.

*My War: My Life.* 2013

This incident made me reflect 1: Specifically, on why I had failed to intrigue my own children about history despite repeated, but admittedly less than expert efforts and, 2: In general, on how hard it seems to be to teach history well. My answer below, which I will have to put to the test with my grandchildren, I wrote more than two years after subbing in this class.

### **Why Teaching History Brilliantly is so Tough...and so Important**

Aquellos que no recuerdan el pasado, están condenados a repetirlo.  
Jorge Santayana, *The Life of Reason* Vol I, (1905-06).

One common translation of this aphorism is, "Those who do not learn history are doomed to repeat it". That sounds ominously like a warning that Geometry teachers might give to their students on Day #1 of class. "Those who do not learn Geometry are doomed to repeat it."

Joking aside, if knowing History is as important as Santayana implies, why does it bore so many kids? Kids, much like old people suffering from dementia, have extremely limited senses of time, space (geography), and complex environmental and human interactions, all, central elements of history. Let us consider these elements and the element of stories, also central to history.

#### **History involves Time.**

It may well be true that, "Those who do not remember the past are doomed to repeat it" (the literal translation of Santayana's aphorism). But children have no past except what is genetically encoded in all of us. Ironically, it may be that coding that dooms us to repeat history while failing to rouse any interest in history, and not only when we are young.

Because kids have no history they only look forward. Looking back wastes time and effort. It is only when time accumulates and a concept of time develops in kids that they can begin to take an interest in history. I came to love history somewhat young, if only in a puerile way, in good part because I became enchanted with time at the age of 10 by seeing the dates on coins. A speck of the great pageant of time opened before me. My son, Evan discovered his love of history on a trip to Pompeii. There he saw more of the great pageant of time unfolded and spread out right before his eyes. Of course, by that time Evan already had his own history – he was 21.

### History involves Stories.

Given that kids dislike history, why then do they love stories? At least part of the answer is that while history looks backward stories look forward even if they deal with past events (e. g., they typically start with, “Once upon a time” and move forward to “Happily ever after”).

Surely another important reason that most kids dislike history, at least in school, is that the stories in history are either not told, not dramatized, or lack magic. History teachers must know how to tell stories, and not only in Grade School. We are all designed to love stories. Don’t we all tell our histories as stories when we dream?

When I was 10 I got a history book in Hebrew School. I loved it. It was the mythology I loved. History within religion is mythology, and mythology is always told as stories involving heroes, miracles (and morals).

Two of my favorite heroes were Samson and Samuel. What was the attraction? I wanted to be as strong as Samson and as wise and revered as Samuel. If I had to choose being one of them, I would have chosen Samuel. Why? First of all, Samson died young. But I was also too young to understand Delilah’s fatal allure to the impetuous Samson and therefore was disappointed in what I saw as his senseless gullibility.

Literature personalizes history. It is good to teach history and literature in conjunction with each other. In High School, we studied at least two of Shakespeare’s plays (Julius Caesar and King Henry IV Part I) without any accompanying lessons in geography and none in history that I can remember. And my history teachers made at most cursory mentions of literature, but only if it had a direct impact on events, such as *Uncle Tom’s Cabin*. What a loss!

There is plenty of historical fiction that could be used as aides in teaching history. When Evan was about 10, he discovered the cartoon book series, *Asterix*. Some time later, he surprised me with his knowledge of ancient Rome and Gaul, gleaned from *Asterix*.

To my knowledge, *Asterix* comics are not included in any school history curriculum. Fortunately, *Johnny Tremain* is. Esther Forbes’s novel tells the story of a boy who played a small but critical role in the start of the Revolutionary War. For this novel, Forbes deserved the praise, “Forbes, a historian, writes with detail and precision, imbuing historical events with life and passion that is often lacking in textbooks.” [Common Sense Media]

James Michener brought history to life and made it riveting to millions like me by interweaving it with stories. I spent a sabbatical year in Israel. My colleague and friend, Zev Levin said to me, “You want to learn about Israel? Read *The Source*!” He was spot on.

A superb example of dramatizing and personalizing history has conquered Broadway. The show, *Hamilton*, written and performed brilliantly in Rap verse and music by Lin-Manuel Miranda and based on the biography, *Alexander Hamilton* by Ron Chernow has been a sold-out smash hit that has turned thousands of kids on to at least that aspect and period of history. Historian Robert P. Watson of Lynn University found that, entirely as a result of this play, his students, formerly moribund when he discussed the Federalist Papers in his college classes, were suddenly clamoring for more. Why? The play is one of those rare combinations of features – the music, the poetry, and the portrayal of Hamilton as an ultimately tragic genius, adventurer, and rake who rose from poverty and illegitimacy to play an enormous role in changing the world. And, of course, once something is seen as chic, it takes on a life of its own.

Hamilton will eventually be made into a film. And there are innumerable fine films that bring aspects of history to life for all of us. Of course, movies tend to stress dramatic struggles and may be designed with agendas that distort history. That gives a history teacher both the obligation and opportunity to correct errors in the film or to have students correct the errors as part of an assignment.

### **History involves Geography.**

Geography includes the physical setting, the climate, and the resources we discover and develop. To gain an appreciation of geography, it helps to travel and explore, especially in person but even through books, pictures or videos. I loved geography from the age of 7 when we city dwellers vacationed at Lake Winnisquam in New Hampshire. The geography of Pompeii, lying prone at the foot of Mount Vesuvius, cannot help but excite awe, and *Asterix* includes many rendered picture maps that help both kids and adults visualize space and distance.

When Evan was 10 or 11 his class read *Johnny Tremain*. His project was to link it to Longfellow's poem, *Paul Revere's Ride*. I knew the Greater Boston area, having gone to graduate school in Cambridge, MA. Upon reading the poem, I realized it described the local geography. We took out a map and found that you could scarcely ask for a more explicit guide from Boston to Lexington and Concord. Pictures and maps should accompany history lessons.

### **History involves Complex Settings.**

School children rush through the Hall of North American Mammals in New York's American Museum of Natural History. Their teacher

stops them before the Environmental Grouping, *Canada Lynx and Varying Hare*, (Figure 20). They see a lynx stalking a hare that is hiding under a snow and rime covered dwarf pine. Will the hare escape? The children are transfixed by the life contest so all they see of the environment is the hiding place and the snow.



**Fig. 20. *Canada Lynx and Varying Hare*. Environmental Grouping, American Museum of Natural History. James Perry Wilson, artist.**

Adults standing in front of the diorama see a more complete picture. Yes, after being blinded by the snow cover the next thing they see is the life contest. Then they read the diorama's legend, which points out the early season snowstorm of late October 1950, the 75-year old dwarf pine and other vegetation encrusted in rime, and the hare's fur, which has not yet turned completely white. They note the mountain-top setting, the distant, bare lowlands with a sliver of the St. Lawrence River, the nearby flattened snow-capped peaks including Mont Jacques-Cartier, and the clearing strips of blue sky above with the orange tinted horizon of late afternoon.

In all the dioramas, children see the animals but remain blind and indifferent to the life-sustaining environment even when it and its significance are pointed out to them. Adults can expand their view to

incorporate the environment, so that they can appreciate the whole life story.

So it is with history. Contrast the complexity of history with the simplicity of geometry. We can learn and appreciate geometry as soon as we acquire the necessary analytic mental powers. But history's complexity dictates that our overview dawns on us gradually. Like a great novel, which must be read at several different stages of life to extract and digest all the juice from it, history must be taught several times over the course of our educations and of our lives. Each time it must be taught in a manner appropriate to our age and intellectual and spiritual development. Each subsequent time should build on the prior exposures. And each time it should tell stories.

### **History involves Interactions between People.**

This is the adult, environmental component that makes history so difficult and goes way beyond hero – villain contests. Understanding human interactions requires maturity, which is why many news events that rile and polarize adults have little meaning to most children. (The proof is that the vast preponderance of ads for news programs are medicines for various adult ailments.) Not surprisingly, an awareness of this central aspect of history didn't even begin to flicker in me until I was 16. My daughter, Elise's interest in history grew gradually through her interest in women's issues and through having children. After she told me her 8-year old daughter was quickly bored when she read to her a bit of *Romeo and Juliet*, she was shocked when I told her that I had read it to her when *she* was about 8 (she had no memory of it) and she too was quickly bored. How intimately then Elise understood Santayana's aphorism.

Given that I loved history, why did I hate current events? In contrast to history, which I viewed as the broad, grand human pageant, I hated the news, seeing it as the narrow, fetid cesspool of trivial, gossipy, bickering biases of the day delivered with no perspective or philosophy. Predating this was my equally intense dislike of the Law. I don't know when this harsh assessment first took root in me. I remember only that while so many others loved Perry Mason and some even were inspired by him to become lawyers, I abhorred the program and was the only one in my family to assiduously avoid watching it. I hated the fray of law and politics, which is precisely what so many others love about it. Above all, I particularly despised the Supreme Court's pompous pretensions of objectivity in the face of their unrepentant biases, bigotry, and yes, cowardice.

My intense dislike of Political Science prompted me to ask my professor a question that any student who hates any required subject should ask their teacher. “Could you, Professor H, find a way to interest me in Political Science given that I view it as a concatenation of rationalizations or outright lies immersed in ceaseless power struggles and ego trips?” There are at least two reasons that most students never ask such questions. First, they are sure they will never like any subject they hate and just want to get it over with. Second, they are not as stupid or naïve as I was. It’s not politically savvy to tell anyone that you hate what they love even if you give the most cogent reasons. Unfortunately, my Political Science professor was no help. Not seeing that I sincerely wanted to understand the allure the subject holds for so many people, he only resented me for my assessment, which the current world of ‘alternative facts’ shows how amazingly on target I was.

What if my political science instructor had been more like Meryl Streep, who portrayed the imperious, arrogant editor in chief of the leading high fashion magazine in the film, *The Devil Wears Prada*? The only job Anne Hathaway was able to get upon graduation as a journalism major was as Streep’s intern. The irony is that not only does Anne scorn high fashion as decadent, she openly flaunts her haughty attitude. Meryl Streep dresses Anne down, demonstrating incisively and compellingly with scathing wit how high fashion permeated and impacted every aspect of Anne’s life without her ever being aware of it. Anne would never become a fashionista, but she did modify her attitude and her dress, and most important, she was taught well and she learned.

Two years after that Political Science course, my friend, David Varady (who was always far more astute than I in the social sciences) chided me for being a poor citizen so long as I remained so ignorant of the news. So I forced myself to read the news, a bitter pill given I had not acquired the necessary perspective. Not only did it confirm my expectations, but alas, it expelled me from my philosophical Garden of Eden and made me feel vindictively smaller minded.

So, it may be that at that time in my life no one could have gotten me to like Political Science, Law, and Politics. But they might have enabled me to see and appreciate its necessary central position in maintaining the tenuous veneer of decorum and order that underpins Civilization, and, given human nature, the reason it involves so much seemingly senseless conflict. After all, people love conflict and combat, even if it is only verbal, for conflict and combat make life more exciting.

It took me decades to find and internalize these answers for myself. In the process I gained a wary but great respect for the Law, for without the Law, as dirty as it can be, there is only Hobbes’ chaos and brutish

nastiness. I also came to realize that current events compile into history much like muddy sediments ultimately metamorphose into the crystalline rock of ages.

From the more general point of teaching, it is not and will never be possible to get students to like every required course they are compelled to take, but it may be possible to get them to see the value and some of the beauty of each course. That would be a major achievement, and any teacher who knows to aim to do that and succeeds is surely a master teacher.

Viewing the time and space of the human pageant gives historians a unique form of wisdom. Psychologists and philosophers focus on other forms of wisdom – introspective and analytical respectively – but tend not to have the temporal and spatial perspective of historians. In a way historians are like the donkey, Benjamin in *Animal Farm*. They get to know human nature from seeing repeating scenarios.

History thus makes sense of the time and place where we stand. And by showing us what and who we are and where we have come from, it enables us to better see, predict, and perhaps even alter where we may be going. By contrast, the news typically reports events in a manner oblivious to that perspective, even when not attempting to enflame our passions and prejudices. Of course, the news media are strongly motivated by money and influence and hence, the news is almost invariably presented in a way to rouse suspicion, anger, pity, and feelings of victimization. It is an ally and prop of conspiracy theories. It distorts and magnifies trivia and gossip into apparent cosmic significance. It fosters and creates hero worship by aggrandizing the runner who wins the marathon by 0.01 seconds while ignoring the runner who comes in second (unless the winner is foreign and the second place athlete is a fellow citizen).

One goal of teaching history is to develop good citizens. History can spur us by glorifying our actions given that events resulting from them accumulate into immortal history.

But teaching history to make more dedicated citizens runs the risk of propagandizing and therefore to selection, distortion, bias, and misrepresentation. Surely, students come to school slathered with prepackaged prejudices on race, religion, social and economic status, and politics, implanted by their parents and communities, and these prejudices rarely change much over a lifetime. [When we moved from a liberal to a conservative town our kids were astonished by the degree to which their classmates in each town mindlessly parroted their parents' prejudices.] To balance the immense power of such propaganda, it makes

sense that an honest history would ultimately produce not merely better citizens, but more important, better human beings.

An honest, robust history certainly makes for more interesting reading than the tendentious texts I suffered through. When I was a college freshman Will Durant had just finished the 7<sup>th</sup> volume of *The Story of Civilization*, and the Book of the Month Club offered all 7 volumes as a come-on for only \$7 (plus shipping). Previously, I had disliked all of my history textbooks. Durant's opus was a revelation to me. It presented, in far greater depth, with much greater wisdom, and seemingly free of advocacy, a holistic view of the human adventure including commerce, travel, science, technology, art, music, and literature that gave life to the inevitable truncated lists of leaders, wars, treaties, and stodgy legal actions. (But reading Durant aloud to my kids didn't work at all.)

I keep thinking of how to make learning history fun...and always come back to telling stories. But even if not fun, history should be made pertinent or better still, compelling. Teaching history in the context of Santayana's aphorism can make it compelling. One approach is to 1: point out, or better, dramatize and reenact in class some historical fiasco such as the Munich Agreement of 1938 granting Hitler the Sudetenland of Czechoslovakia and how it opened one of the furnace doors to the inferno of World War II, 2: Show or dramatize how the fiasco resulted from ignorance and errors or outright failure of judgment, and 3: Link the past event to a current issue. Most people will feel challenged to think how they might have handled the past problem and how they might handle current problems, given the thorny constancy of human nature.

So, now you are president! What will you do about the mess in the Middle East or about the threatening travesty that is North Korea? What will you do about Putin's annexation of Crimea and sneaky invasion of the Ukraine? Is Putin being appeased as Hitler was when he demanded that Great Britain and France give the Third Reich the Sudetenland as a gift? Will failing to stop North Korea or Putin now lead to graver costs in the future? Will our decisions force us to say what Winston Churchill said of the Munich Agreement? "Britain and France had to choose between war and dishonor. They chose dishonor. They will have war."

These are all tough questions. Sometimes unfortunately, we can learn from the past only in retrospect, when it is too late.

### Day #35: The Blind Side of Biology

The day's assignment at San Mateo was Bio. Someone up there must have been watching me, because the first class, a group of restless, immature 9<sup>th</sup> graders came equipped with a life-saving Special Ed Teacher. She took charge, keeping the class mostly quiet with ceaselessly repeated warnings and firm but gentle threats. She kept them quieter than most of my classes. She was able to ask questions of individual students by name. Although not a biologist, she had some knowledge of Bio. Clearly, her main job was to keep them in order.

The other Bio classes did not need a Special Ed Lion Tamer. There, my job was to show the film, *The Blind Side*. Recall that on Day #14, I showed it in Math. The issue of whether *The Blind Side* provides less insight into Math or Bio would make for a marvelous debate.

I encountered technical difficulties in my attempt to get the video started and called for help. The Dean of Death came in first, perhaps because the room was noisy. The kids immediately became silent. Having done his job (he also failed to get the video working), he left without ever even glancing at the lowly Sub. The Principal came in next. I had never met her before. She was unassuming and made eye contact; I liked her. She repeated all the steps I had taken. But the projector still couldn't find the computer. Ultimately a technical engineer came in and, after repeating everything each of us had done, surmised the problem was electrical. He left, returning a few minutes later with a new Y-junction, with which he replaced the old one, and the video started. I continued it into the next period - study hall – so that students could see the end.

## Day #36: The Stranger: Arrogance at Aragon: Literature, Art and Weather

Several days before I subbed again I got a call from the Central Office of San Mateo chastising me for the survey I had given in Aragon. It was the third time I had been told off for the same infraction. This was getting more than tiresome. It turned out to be a prelude for my next appearance at Aragon.

The Administrative Assistant asked me to cover an extra class. Guess who she wanted me to sub for? You got it – Daniel. I told her point blank that he was the one teacher I would not sub for because he had been abusive to me and because he wouldn't want me anyway. So to keep me busy she sent me to the library to offer my help. They neither needed nor wanted me. Five minutes later I was called back to the office to sub for a late teacher the late teacher arrived just as I did. So I was sent back to the Library, where they still didn't need or want me. While I was sitting there, reading quietly, a *Stranger* walked up to me out of the blue and, with no introduction, began upbraiding me for my camera, warning me not to photograph students.

We had an unpleasant interaction. I was sick and tired of these police state actions so I reacted sharply. [I should have read *Wait* and practiced slowing my knee-jerk reaction.] Guess who the *Stranger* was! She was *The Principal*! She informed me (for the  $n^{\text{th}}$  time) that taking photos of students is even more heinously criminal than taking surveys! When I offered to show her my photos, she didn't care to verify my claim that I only photograph clouds and scenery. It occurred to me that Galileo faced a similar refusal when he offered conservative 'philosophers' a chance to look through his telescope. But I showed her anyway. She couldn't have cared less and told me so. When I asked her if I were permitted to ask the students what their favorite book is, she said, "I won't go there." She said instead, "You have no idea how litigious my job is." (I do.) She was corralled by fear of threats and litigation with all the associated misery that might be heaped on her. How typical of the Education Empire's Reign! All rules and regulations with no substance or goal other than intimidation!

She was a clear case of an administrator who operates under an aura of fear and intimidation and transmits that down the line. Thank God my career as Professor had been largely free of such small minded malice. But be forewarned: colleges are increasingly becoming high-schoolized.

Looked at from the outside, this epic, raging battle was a comic skirmish between two dwarfs – anger and fear – in which fear claimed the day because it had authority. A comic skirmish, yes, but it upset me.

After the skirmish it took me some time to calm down somewhat. What helped was my mantra – “The classroom is the teacher’s Empire.” Once the classroom doors are closed, teachers are free to perform their sacred mission, educating the world’s future leaders. Of course, the moment an officious or punitive administrator walks in, the teacher must be sure to tow the line and can never be sure of exactly how to do it properly.

Even so, I went to the first class shaken and downcast. On the board I wrote my name and in tiny, self-effacing print, listed the three books I have written. The writing stayed up all day. I don’t think one student in 150 noticed. I kept my introductions to a bare minimum, took the attendance and retreated to my corner.

The day’s assignment was oddly appropriate. It dealt with Camus’ *Stranger*. Because I had never read that short novel before I read it from cover to cover. That led to some good interactions with the students and encouraged one student to ask me a question – “What does *vigil* mean?” So few students ask questions – so very few!

Somewhere in the middle of the day I recovered my equilibrium enough to realize I could tell the students about the prints of famous paintings on the side wall. One was Gustav Courbet’s *Cliffs of Etretat after a Storm* and another was Claude Monet’s *The Beach at St Adresse*. I walked over to the prints and began to describe them.

“Gustav Courbet and Oscar Claude Monet were marvelous artists in good part because they were incredible observers. Courbet was called a *Realist*. He was the first to paint a naked woman with almost photographic accuracy. His painting, *Cliffs of Etretat after a Storm* is also nearly photographic. It shows an accurate view of the chalk cliffs on the north coast of France. It faces west. The delicate white clouds, called altocumulus, are often seen after a storm. The wind blowing the waves comes from the NW, which is a typical wind direction after storms.

Monet discovered his talent for art early. As a 16 year old, he made good money drawing caricatures of tourists in the beach resort town of St. Adresse. An older painter, Eugène Boudin told Monet to stop wasting his time with caricatures and to follow him and start painting nature. After some time, Monet took Boudin’s advice. His painting, the *Beach at St Adresse* is actually the second painting of that day. The first, painted a few hours earlier is called *The Regata at St Adresse*. It has a much sunnier sky with small puffy cumulus clouds over the distant land. But as Monet was working on the first painting, thicker clouds called altostratus advanced to cover the sky and darken the scene. Monet had the insight to start the second, showing all the changes of lighting, etc.

Together, these two paintings describe an oncoming storm. Almost surely it was raining by the next morning. These two paintings – *The Regata* and *The Beach* represent the first series Monet ever painted. His more famous series include Haystacks and the Rouen Cathedral at different times of the day.

When I finished, one student asked, "Didn't you sub in our math class and write a book on Calculus." A few of these AP students were astonished because they didn't expect anyone who knew math would also know about art.

I asked the students if they had read anything by the authors before taking the class. None had – neither Camus in the regular English classes nor Conrad (*Heart of Darkness*) in the AP class. I asked if any would read anything more by these authors and was baffled when I got almost no response. Then, a student cleared the situation. He said that they had just begun these books so they had no basis for such a decision. It was a good, appropriate, and accurate answer.

The AP class had just finished *Crime and Punishment*. I told them they absolutely must read the *Legend of the Grand Inquisitor*, Ivan's short story in Dostoyevsky's *Brothers Karamazov*. I compared the Spanish Inquisition to ISIS, calling the Inquisitors the ISIS of Spain. That resonated with one student. I then told them enough of the *Legend* to whet their appetites. All the students listened in dead silence, just as they did during the description of the paintings.

But this was the AP class – in the regular class the period before I couldn't get their attention and gave up. They didn't care. I gave to two genial students who showed no interest in doing any part of the assignment the brain teaser of getting the 3 cannibals and missionaries safely across a river with a boat that can only hold two people (See Day #7). This briefly interested them but the moment they got stumped they gave up and deferred to the students who had the reputation as the class geniuses, one of whom finally figured it out.

At the end of the day, when I returned to the Administrative Assistant to hand in the keys I told her off for siccing the Principal on me. She admitted that she did. I let her know that I was tired of false and gratuitous accusations when I was doing such a good job. She responded, "You must admit it is unusual to carry such a camera." My camera is an SLR with a medium size zoom lens. She had seen me with that camera every day I had subbed in Aragon and knew I only photographed the sky and never the students. Later that day, one of my nephews pointed out that everyone has cameras. They are called cell phones. But taking that survey had put me on the administrators' radar, and once you get on the administrators' radar, they hone in on you and you don't get off.

As I walked home I told myself that being among and possibly guiding students gives me great pleasure while being forced to deal with rule-encasing administrators gives me (and has always given me) great displeasure. And it ain't just me that feels that way!

What grand conclusion do I draw? Thank your lucky stars if you have one of the admirable administrators who facilitate teachers and even lowly Subs, seeing them as allies, for they set a positive mood of the school. Forget the punitive administrators while they confine their prowling to the halls outside the classroom walls. It is in the class where you can help brew miracles. There, you provide the training and instill the discipline that should help equip students to handle anything life may throw at them. There, you may provide the spark that will ignite the love of some subject or better yet, the love of learning in a student for a lifetime, changing his or her world, and maybe even changing the whole world. The classroom is one of humanity's great brain labs. The Sub plays a tiny, tiny serendipitous role in sparking the miracle of the love of learning, but a role that may turn out to be monumental.

## After the Fall

I had a wonderful winter in Florida – reading, writing, biking, swimming, and playing the piano. In the Spring, a few days after I returned to San Mateo and adjusted to the time change, I attempted to log onto AESOP. Strangely, my ID or Password did not work. After a few failed tries I called the central office. Then I learned that as the result of three complaints my services were no longer required or desired. No information could be forthcoming about those complaints because by contract, Subs have no right to that information.

I was irate, humiliated, furious, but most of all, I was fired! I stopped writing *Sub Ways* immediately. I write these words now, almost two years after the event.

Why did I put *Sub Ways* aside for so long? When my feelings are in the meat grinder I can't write with objective passion, which is one of my prerequisites. I had to calm down by smashing some of our ugly furniture, stabbing voodoo dolls and other similar activities. That took some time, during which I read more books on education, history, and literature. I both took and taught classes for seniors. I continued aiming at becoming a better teacher and understanding what it is that makes a great teacher.

During my time of rage and shame I vented to friends and relatives about my piteous plight. Reactions included sympathy and surprise but two good teacher friends, reacted with hostility to my actions as a Sub. Both felt that I had acted out of bounds and should have restricted my subbing activities to exactly what was in the contract; namely, in each class hand out the assignment, then sit quietly and make myself available to any questions I could competently answer. These friends felt that by arrogating to myself a more active and meddling role (including the surveys) not only was I in clear violation of contract, but worse, I may have disrupted the flow of the courses that the regular teachers had wanted. To say the least, I was surprised and miffed at their lack of sympathy and even outright anger at me. No, I didn't like it, but I can take it, and, of course, in a way they were right. I took a risk and paid the consequences. But if I had to do it all over again I wouldn't change anything about the substantial role I played in the classes as a Sub. It was a short run but I gave it my best.

## Summa on Teaching Excellence: Back Home Again

My termination as a Sub did not stop me from thinking about teaching excellence. Indeed, it occupied my thoughts more and more. To paraphrase another quote – you can take the teacher out of the classroom

but you can't take the classroom out of the teacher. And, as I mentioned, I have never left the classroom. I continue to both take and teach courses, now with other mostly senior citizens. And every step of the way I have thought and thought and read about teaching excellence and have finally reached some sort of personal summa.

Throughout *Sub Ways*, and especially in the later part of it, I have almost obsessed on the subject of teaching excellence. I have covered many aspects but there is one crucial issue or factor that goes into teaching excellence that I bypassed. I have stressed that enthusiasm is a key ingredient in teaching excellence. Master teachers should be impregnated with enthusiasm for learning, for their fields, and for their students. But there is also a form of mass enthusiasm that drives people to learn. Call it the Craze Factor.

### **The Craze Factor**

At different times and places there have arisen new ways of seeing the world and new enthusiasms that inspired and mobilized people. So it was with the Crusades, with art in the Renaissance, classical music from roughly 1700 to 1900 and various forms of popular music since then, physics after Kepler, Galileo, and Newton and again after Einstein, science and technology in the United States at least after Sputnik, and most recently, computers. Teachers in these fields have a great advantage over teachers in fields considered irrelevant or unimportant or passé by the society. For, by impassioning entire communities, crazes inspire simultaneous cooperation and competition.

Crazes almost always arise outside the schools. Intellectual crazes always motivate people to learn, so schools are wise to incorporate them in the curricula. Consider again the play, *Hamilton*. Robert P. Watson claims that he listed Alexander Hamilton's life, work, and influence as one subject of his public lectures. For 26 years, he did not get a single bite to speak on Hamilton. But from the moment the play became a craze (or chic, as I said) he has gotten too many requests to handle.

Schools have a great disadvantage regarding crazes. They are by nature almost compelled to institutionalize and mandate whatever they touch, but that drains the lifeblood of crazes. Tom Sawyer managed to transform whitewashing the fence from work to play but schools almost invariably work it backwards. As my brother-in-law, Norman aptly said, "Schools would take the fun out of sex."

One final, great problem is that Public Schools are simultaneously a requirement and an entitlement, so they must take and keep everyone thrown their way. This places them at a great disadvantage to Private Schools or Charter Schools, which are selective. Comparisons are then

inappropriate because it is as if the Public Schools must sell kids broccoli when Private and Charter Schools are allowed to sell kids candy.

Of course, most teachers must cover subjects that are not crazes, i. e., they must sell broccoli. How then is a teacher to inspire the uninspired or to captivate the captive audience? If one aim, perhaps the central aim of teaching is to enrich a student's life then it is likely this will be done through love. What love? Early on in Elementary School, love of the student may be primary, but by High School, love of learning, love of accomplishment, and love of the subject will usually dominate.

In the film, *The Miracle Worker*, Annie Sullivan (played by Anne Bancroft) yearned with all her heart to teach 7-year old Helen Keller (played by Patty Duke) the vital connection between words and their meaning, but confessed, "And I don't even love her." But what began solely as love for learning broadened to encompass love for her student, once Helen finally made her great discovery – Wawa = water.

Therefore, I repeat what I wrote back on Day #18. "Asking what makes a great teacher is like asking what makes a great lover." It is true that everyone has their own unique loves. But someone who loves strongly enough can sometimes inspire others to love in turn. So teachers who are enamored of their subject, of learning, of accomplishment, and of their students can sometimes convey their loves to their students and open their students' eyes to new worlds. This love can't be faked (but it can be squelched by excessively rigid enforcement of pedagogical formulas).

Therefore, to be the best teacher possible, any teacher must embody all the qualities described above, and in a manner true to his or her own strengths and personality. Frank McCourt confessed in his memoir, *Teacher Man* that he constantly compared himself unfavorably to teachers who had more disciplined and authoritative personalities and approaches that he simply couldn't take or match. He was too humble and had to slowly learn that he would be the best teacher he could be if he remained true to himself. After that, to the extent that it is possible, great teachers must be aware of the needs of each student. They should never lose sight of the fact that their students are developing fellow human beings; in school they sit in the classroom under a good degree of compulsion. Give to the students the enormous credit and praise that must accrue to any amount of learning, for learning is a revolutionary change – exceedingly difficult to accomplish, and when it occurs it is always one of the great and elusive miracles in the Universe. All this makes the very existence of a master teacher a miracle of miracles.

And, do you know, I pretty much knew this all along. I just had to learn it all over again. And relearning it felt like coming home.