ACADEMIC FREEDOM

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This note concerns the increasing pressure felt by students in order to climb the academic ladder. For various reasons, schools have become pressure cookers with a lot of negative consequences.

I'll begin by describing the almost total lack of pressure in my own education. This lack of pressure is due to when I was born, to my parents and some to my own inclinations. Anyone interested in where this freedom has taken me can check *math.unt.edu/~jwn* and *genealogy.math.ndsu.nodak.edu*.

I started school in a one-room school house with nine grades but just six students. I was the entire kindergarten (called 'primary' in Iowa). The teacher would call us one by one to sit in the chair next to her desk. In my case, it was always a pleasant interlude. There was never a sense in my mind that she wanted me to do something. She would often mention something interesting and let it go at that. I spent most of my school time listening to her interacting with the other five students. I learned to read with pleasure and could add columns of numbers and do other arithmetic. I believe it was about that time I began to imagine patterns with numbers, but maybe that was later.

We lived on a farm, in an old house in Iowa. My bedroom was on the second floor with only a stove pipe for heat. After the initial shock of getting into bed, I felt quite comfortable. I would often lie in bed and think about all sorts of things. A favorite was to think of processes which constructed very large numbers (e.g., start with a number - a positive integer since I didn't know any other kind) double it in a second, double it again in another second, and so on. I would make variations on this, but two things troubled me, the first I could articulate then but the second only much later. The first was that no matter how I constructed my process I could alway do better (double my current number *twice* in each second). The other concern, which I can now articulate, was that my schemes could run out of numbers in a relatively short time (double in first second, double again in the next half second, double again in the next fourth second,....).

After this primary year I was saved from the one-room school house and put in a consolidated school in a nearby town. I found almost nothing new at this school in the next three and half years. My primary teacher evidently fed me lots of things, but it was just in pleasant conversations in which I felt good about an adult talking to me for a while, but in the town school, the teachers were always talking without a point being clear to me.

There was an exception in my town school experience. One day in the fourth grade, my teacher came in with a worried look. She was concerned that what we knew about subtracting was only the standard method - where one 'borrows' if the current digit below is larger than the one above it. She said that instead of borrowing, we could essentially add ten to the number above and also add one to the number to the left of the below number. I've used this exclusively ever since. What impressed me so much was that the teacher was really interested in our knowing how to do this. It really meant something to her that we understood this.

In the middle of the fourth grade my family moved from Northern Iowa to Brownsville in the Rio Grande Valley in South Texas. Cultural shock, but a family adventure. I started to learn some Spanish. Maybe nine out of ten had Spanish as their native tongue, counting Brownsville's sister city Matamoros, just across the river. Schools had Spanish courses but instruction in that language was poor, taking no advantage of where we were. My parents business, my own business and the streets were another story. I got a foundation that I was able to build on. Many decades later, I conducted a summer school in Merida, Venezuela. Every word was in Spanish, both inside and outside of class. Even wrote a problem book in Spanish. I didn't lecture but rather asked the students (faculty, graduate students a few undergraduates, all from Latin America) to present their work on problems in the little book.

Schools in South Texas were considerably worse that the 'town' school in Iowa. I pretty well tuned out. One thing I did notice was that some class periods were different from most. The teacher didn't talk much, but she would write some questions on the board. It was clear that we were to write something on our paper in response, but this whole exercise was rather vague. Later I found out that this was 'test' time. I never had a clue that one of these times was coming, but I seemed to always write something down that kept me out of trouble. It was only in the eighth grade that a saw a fellow student with a paper

full of neatly written notes. She somehow knew a test was coming. On her paper were things the teacher had evidently talked about and what she had written was in preparation for a test that I had no clue was coming. After that I would often notice a test would be coming and started to make some preparations.

I had an intellectual life and I went to school, but made essentially no connection between the two. However in the eighth grade, I had the coach for Texas History. He would tell us stories about Texas. One example was that people on farms in East Texas often had somebody with a loud voice who could shout out brief messages to a neighboring farm. The message would be relayed by someone also with a loud voice and eventually reach an intended person. Don't try this with 'War and Peace'. Another was that sometimes neighboring counties would have some dispute and one of them was able to cut off the supply of salt to the other county. It is clear that a way to make someone angry is to deprive them of salt. Every bite of food came with a feeling of resentment. The coach gave us Illustrated Texas History books supplied by the Mobile Oil Company. Have been interested in Texas history ever since.

My fifth and sixth grades were in the same room, with the same teacher. Well into that school year, my teacher, Mrs. Federer, jumped me from the fifth grade to the sixth. She effectively gave me an extra year of life.

In high school there were only a few bright spots. My social life was meager there, with my views and those of my fellow students being so different that there was almost no point of reference. I would often miss classes to fill the coke machine. I stayed home a lot, helping my Dad in his butane gas business. We would go out on service and selling calls, working especially hard during cold snaps in South Texas. We were almost like a public utility and felt a lot of responsibility. There was always time, however, for chicken fried steaks and pin-ball playing in the dives near the port, no matter how late we worked. More on high school later.

I loved the business and learned to do everything. Even ran the place for a summer when my parents left for health reasons. I was fourteen years old, had my driver's license and could make business calls, even into Mexico. As my parents pulled out of our driveway, to be gone for the summer, I had a 'heart falling to my stomach' feeling. I grew up in a few seconds. The butane business is serious.

Even before that time my sister and I had a restaurant. We made the best hamburgers I have ever tasted. (Cut a bun in half, put a hamburger patty on the grill and also the cut bun sides face down on the grill. When the meat is flipped over put the top half of the bun on top of the meat, removing the bottom half to prepare with mustard or mayonnaise. Put on lettuce, pickles and onions and most importantly a big slice of the excellent tomatoes from South Texas. Serve quickly. The buns were crispy, almost like toast). Later I will tell how it came to be that I didn't stay in either the butane or restaurant business. But now back to high school.

We didn't have any laboratories in my high school, but did have a biology course. I learned about the classification scheme for plants and animals, something I have always been glad to know. I had a good accounting course. We essentially kept books for a small (imaginary) business, figuring balance sheets and profit and loss statements. My senior year, we had a new English teacher, a recent graduate of the University of Texas. She loved Shakespeare and brought her seventy eight rpm record player and a great stack of someone reading Macbeth. We had a good time with this. She didn't have a car whereas I had a wonderful, very fast one (which ran on butane, methanol and even gasoline in a pinch.) I often took her places. I was editor of the year book and she was the faculty sponsor, so there was a lot of running around with that. She also introduced us to the Indo-European family of languages and told us how Sanskrit figured in. I mention here that my high school had fewer than eighty students and was out in the country. Most of my friends went to the much larger high school in Brownsville. I knew them through church activities and the chess club at the larger school. Anyway, the biology, accounting, and senior English sum up the bright spots of high school. Geometry class met only about 7 days for the year - the teacher being the superintendent and very busy. Two years of algebra was hardly worth six weeks. No chemistry, physics nor any mathematics beyond geometry. I solved systems of two linear equations in two unknowns only by trial and error. If the answer was $x = \frac{4}{17}, y = \frac{13}{3}$ it would take me a while.

During my last semester in high school, I enrolled in the local community college, Texas Southmost College. Only two of my five courses transfered to my next stop, the University of Texas, but I tried to not let the loss of the three course credits ruin my life. Algebra was even worse than my high school algebra, English was quite good but I had to write only one theme, my first one ever. For that I had way too much help: My sister Marcia, an English major in college; my friend

Bill Feilds, a writer, poet, chess teacher, harmonica player, exquisite bilingual joke maker, and an eventual PhD holder; my friend Rudy Troike, who became and remains an eminent linguist. This first theme shouldn't count since there was so much expert help.

At the age of sixteen, I graduated from high school. After the graduation ceremony (only five of us there; two already in the military), I took a drive on some South Texas back roads and was in bed by 9:30. At 5:30 the next morning I picked up Rudy and we headed for Austin to enroll at UT and arrange for somewhere to live. I wasn't aware of the idea of college applications. I thought that one more-or-less just told a school one wanted to come. I sent letters to only two places: UT and Rice University. Many decades later, when I was writing a letter of recommendation, I realized that I had read only the second half of my letter from Rice. It was a list of my deficiencies. I then realized that Rice must have admitted me in the first half of the letter. Even Rice wouldn't say in the first part of a letter that I couldn't come and then in the second part list my deficiencies. But I was having none of *deficiencies* that day.

I was born in the depths of the Great Depression. My parents told me that the prevailing wisdom was that children shouldn't be brought into a world with such depressing prospects. As a result of the result of these demographics, I had little competition. When I started college in 1951 the World War II veterans who swelled college enrollments right after the war were largely gone, making college admissions very easy. Getting a job after finishing graduate school was almost a matter of picking up a phone. An employment crunch came more than a decade later, after I was established in my work.

My parents gave me almost no advice as I recall. I worked hard in their business and they were very generous, particularly in providing me with a nice, fast car. One bit of advice that they did give was that they thought I was too young, right after finishing high school, to stay in Brownsville to work in their business. They must have known that I had inclinations to stay. They recommended that I go to college for a few years, with strict instructions to grow a bit older. I could have gone anywhere. I had this wonderful car, I could write checks on the family account and I had no hint from them of an expected outcome from college, or even if I should try to graduate. I chose UT in Austin. My own requirement was that college be within reasonable driving distance from Brownsville although I really liked Los Angeles, the center of hot-rod culture. Now if Mexico had had a super highway from Tijuana

to Matamoros, with no speed limit..... I still dream of driving my souped-up car, big V8 wound up tight, twin Smitty mufflers echoing doom, middle of the night, full moon, Chihuahuan Desert, music from XEG, Going Home - eat your heart out, Greek Mythology. Later I lost interest in fast cars. A fast car one can buy seems pretty tame compared with a fast car one made oneself. We now have a couple of hybrids. In recent years, I gave the Mercury to a nephew. He wanted it for more than twenty-five years. It was time he got it.

Television came to South Texas after I left for UT. Have never lived where there was a television. I figure I have missed about a million commercials in addition to stuff between the ads. This gained me a lot of time, much of which has been spent doing mathematics.

A few more words about my parents. Both went to one-room schools in Iowa. When my Mother finished eighth grade, in order to go to high school, she left home for the county seat, Garner, to work as an *au paire*, we would say now, in exchange for room and board. After high school graduation, she had six weeks of teacher training. The next fall, she had her own one room school with some thirty five students, some about her age. She lived with the family of one of her students.

My Dad was an avid reader, interested in many things even though he went through only the eighth grade. One time he went to the family mailbox and saw the newspaper headlines, sat down by the side of the road and read the whole story: The Titanic had sunk. He told me he had understood every word. He was not quite seven years old. When we moved to Brownsville he was elected head of the school board, putting a struggling school in better financial shape. He handed out high school diplomas. He might well have made out one for himself.

My parents eventually sold their business. Characteristically for our family, we never discussed the matter. We all knew I wouldn't be coming back. After the sale my brother-in-law asked my Dad what he would do now. My Dad looked at me and said he might go to college. Asked what he would study, he looked at me and replied 'Mathematics, I figure if you can do it, so can I'. My parents actually started a new business, one they could run by themselves.

To this day, I miss the cold rush of escaping butane when removing a filler hose. On a hot South Texas day with nearly saturated humidity, that rush gives a welcome chill.

From among the schools within acceptable driving distance from home, I chose UT. It had an interesting reputation of being a somewhat

ominous place. In retrospect, I realized that it had an exceptional group of fiercely independent working intellectuals. That aura kept most of my friends away, but was a lure to me. When I first registered there, in the engineering route to BBA, in the business school, I asked my advisor (one picked an advisor from one of a room full of advisors - and took the first one available) if I might take 'Introduction to Poetry' instead of a standard sophomore English course. He looked me in the eye and said, 'This is the University of Texas, we do as we please' (He might well have added 'and take the consequences').

The poetry course was a washout - just someone droning on about who knows what, but my second Sophomore English course turned out differently. The material was standard for a survey course, some poetry, some Shakespeare, some short stories, a novel or two, and a book of modern dramas. I did poorly though the semester, contributing nothing to class discussions, did poorly on tests, wrote miserable themes. Then came the final. At UT in those days, fall semester finals came two weeks after the Christmas break. I had my five or six other finals crammed into the first few days and then had a five day break before my English final. I went home to Brownsville, but instead of helping my Dad I sat in our living room and read all the material from the course. The first question on the final was something like this: 'How do writers of fiction try to make a point to their readers? Frame your reply in terms of our book on modern dramas.' Something snapped. My first sentence was like this: 'The authors of these dramas were a bunch of degenerate pessimists who were trying to spread their pessimism to others.' I wrote like a demon for about an hour. Am sure my teacher actually liked the book of dramas, but he recognized a piece of literary criticism when he saw one. He gave me an 'A' and we had a nice chat about my taking more English classes. The whole episode gave me a big lesson: Write only when you have something to say.

Decades later I was to give a talk at the Engineering School at UT. I arrived at the campus early. On my way to meet my host, I passed the English building. On a whim, I went inside and noticed that my English professor, Alexander Sackton, was still listed on the directory. I knocked on his door and was surprised to hear a weak 'come in'. He was retiring at the end of the semester to go to England to finish his book on Keats. We chatted about the Modern Drama incident and how it affected me as a teacher. Whenever a student of mine would tell me they had a 'C' going in my course, I would tell them that if they

could manage to open their mind and start to think, they could still make an 'A'.

Besides my mathematics courses, described a little later, courses at UT were a mixed bag. Took three semesters of Spanish, including a special conversation course for non-native speakers of Spanish. Never once did a teacher ask me a question in Spanish. They just droned on about grammar for the most part. Really inferior to the streets of Brownsville.

My geology course was good. The teacher told us the first day that this first year course was the one place where we could get an overview of the subject. He told us that the last several MS geology graduates had all found their first oil well. Turned me into a geologist-in-spirit.

A government course led me to realize that the Texas Constitution badly needed a change. It was written after Reconstruction and was (still is) absurdly detailed. Our teacher told us that according to this constitution it was illegal in Texas to carry a pair of pliers in one's car - a holdover from fence cutting days. The course left some of us itching to change the constitution. No luck with this yet.

Took a lot of physics, but these courses had little effect except for a summer course in atomic physics for which I didn't have the prerequisites. In the six weeks course we had a lab with ten substantial reports expected. I had three lab partners, all with a lot of experience, so I didn't get much out of the lab, *except* for one thing. One of the ten projects concerned the Millican Oil Drop experiment, a result of which the 'bundle' rather than the 'continuous' model for electricity was established. This was one of the premier discoveries of the twentieth century. I wasn't doing well with that experiment, thanks probably to too much help from my able lab partners, but then came a fateful Saturday. I went to the physics building early and found it locked. I managed to crawl in through a window and set up the experiment - a waffle iron like device with a telescope pointing inward and a little radioactive source inside. One would squirt in some very light oil, pick a tiny oil drop and record its time between two markers, reversing the polarity of the two sides of the waffle iron to make the drop reverse course. A drop might lose an electron, but due to the radioactive source, a drop would gain an electron occasionally. The drop never sped up or lost speed only a little, but rather the speed changed markedly from time to time. An analysis of resulting data essentially confirmed the 'bundle' nature of electricity. An undergraduate climbing through a window on Saturday, running this exotic waffle iron, using a radioactive source,

working for ten hours or so - this was the only real experiment I did in maybe fourteen physics courses, but this experiment showed me a lot. My graduate quantum mechanics course was taught by someone who entered class looking like a deer caught in headlights. I never was asked a question, let alone asked one myself. I learned some quantum mechanics eventually through consulting work. Classes in physics were generally drone-on, drink-from-a-fire-hose courses which left little impression. My mathematics courses were so much better.

Mathematics during my first year at UT was mainly analytic geometry, which together with a six-week summer trigonometry course at TSC gave me a first glimmer into mathematics. It was in my second year at UT that my luck changed. Will first give some background on UT and mathematics in those days. There were two mathematics departments, Applied Mathematics and Pure Mathematics. Applied Mathematics taught many more students and nine out of ten students would advise taking courses in that department. The one out of ten had a different story, one that the few Pure Mathematics teachers had something very interesting to offer. The ring leaders in this department were R. L. Moore and H. S. Wall. They never lectured, but rather developed their courses by means of sequences of problems stated one class period and asked about at a later class. These two were at the heart of what has become to be called various names: 'Moore Method, Discovery Method, Texas Method, Inquiry Based Learning,...' Between them Wall and Moore directed more than a hundred PhD graduates, many of whom did very well in mathematics. I was at UT for six years, stylishly long for these days, but in my case the time included both undergraduate and graduate years. In my second year came calculus under Moore. Moore's calculus class turned me into a mathematician. It was a good general course, but he was looking for mathematicians. He was patient and did not give a high-pressure course. He used a good notation in terms of which it was possible for calculus to be clear. In my third year I had differential equations with Wall. This course set me on a research path which has lasted to this day. Neither of these were lecture courses. Years four, five and six were graduate work. About the start of my second graduate year, I got an idea and slowed down work on my courses in favor of pursuing an idea: In those days, Mathematical Analysis meant *Linear* Analysis. I asked myself, 'why all this stuff about *linear*?' It turns out things didn't need to be linear at all. I found some nice nonlinear results. Wall asked me if I wanted to 'get out', local parlance for finishing a PhD and leaving. After a little thought, I decided that would be OK. Now I really had no specific

academic nor employment plans. I had hung around graduate school as a default choice. We had no qualifying exams nor any other 'steps' to take other than writing up a good piece of publishable research. It turned out that I completed my first piece of research before I knew I was even starting 'research'. The work grew naturally out of the Moore Method courses I took. Research, it turned out, was just like my course work. Most of the time, we were trying to solve problems. We were held to a high standard in presenting our work. The only difference between course work and 'research' was that in the former, answers were already known by someone but in the latter no one yet knew an answer. The two modes made no practical difference to me in that in each I was confused and engaged in self-defeating tactics most of the time, this being interspersed with occasional insights and attacks of lucidity. More than five decades later, this is still my pattern of 'work', a term I use almost in jest. Something as fun as this probably shouldn't be called 'work'. Same for teaching. When one is trying to get students to open their minds and see benefits of an intellectual life, one is compellingly engaged. It's not like real work (digging ditches in the hot South Texas sun is *real* work).

After my sixth year at UT I graduated. Didn't have enough course credits, but they let me out anyway. Three years of graduate work might have been enough, but my second year I was teaching two courses and my third year I was a Special Instructor, teaching four courses. I didn't count as a full-time student, but the Graduate Dean just heaved a sigh, saying that 'those guys over there (Moore and Wall) just run their own graduate school.' When I left UT, Wall told me 'when a man learns to teach himself, there is nothing more we can do for him'.

After I graduating, I resumed my summer work with General Dynamics, this time with the title 'Senior Nuclear Engineer'. My job there was to help develop a nuclear powered airplane. I was calculating how to distribute the necessary water, lead and concrete in an aircraft. Health Physicists in our group took parachute training.

After that summer's work, I cut my salary in half and headed for a teaching job at the Illinois Institute of Technology, in Chicago. I had written UC Berkeley, University of Wisconsin and Northwestern. Berkeley said they were sorry, they had only a one year position. The person to whom I wrote at Wisconsin said he was no longer the Chair, but he was sure they would have something for me. Northwestern invited me up for a visit. I took a job at IIT since I suspected that my funny way of teaching might be better tolerated there than at the three

better known places. In retrospect, I probably would have been OK at any of the first three places, particularly since faculty in mathematics were in such short supply. At IIT, there were already two from UT, Pat Porcelli and Bill Mahavier. They had pretty well worn down the rest of the faculty there with the heresy of Moore's teaching so that is why I thought I would be more likely to survive there. My first year at IIT I started to direct PhD students and taught my first graduate course. I had just turned twenty-three. Some of my students knew more than I did, but I had drawn blood on research and they hadn't yet. After two years at IIT, Porcelli, Mahavier and I left, taking thirteen PhD students with us. Many of these students became fine mathematicians.

After first being heresy, then having grudging tolerance, then some acceptance, IBL has become a respectable method of teaching at some universities and colleges. One might get a grant, even a Federal grant, for developing IBL course materials. Can one get any more respectable than *that*?

Frankly, IBL was even more fun when I was an academic outlaw.

As I indicated, my own background gave me exceptional freedom: I had a lack of family pressure but somehow had a largely unspoken understanding with my family. I felt no pressure to do anything 'prestigious'. I knew how to run a business, to make things, fix things, to deal with the public, cook excellent hamburgers. College was just to grow older, graduate school just a self-supporting lark. Early on, while still in graduate school, I started to do consulting work, generally through relationships which lasted a long time. I always managed to easily grab freedom to teach as I wanted despite opposition. I felt no significant pressure from any group of mathematicians. Well meaning advice to join a mathematical 'mainstream' was brushed off. I took the freedom to do mathematics as I wanted, even spending some years on almost hopeless problems, some of which I eventually solved.

I'll close with a few points on education. The first concerns teaching in a general sense. How would the lecture method do in teaching someone to ride a bicycle, to play a violin, to fly an airplane? In view of your anticipated answer, I ask about mathematics and other subjects. Does hearing someone talk about something endlessly help someone be creative or even generate a good working knowledge? Academic subjects come in a great variety, but a common thread is that students need to be given problems and tasks on which they can work and ponder for a while, then be asked by the teacher (in class preferably) what they

have found. This builds confidence and some early maturity and allows students to learn from their mistakes and mistakes of their classmates. Students in such a class get to know each other and can see clearly the progress of others.

Lecturing might be fine to teach art appreciation but learning to paint is another thing entirely.

Today, the academic world grows ever more oppressive, governed by 'teach-to-the-test', 'fill in the bubbles on standardized tests', 'build up an impressive resumé', scramble for every crumb of early prestige. Who are students supposed to impress, anyway, in applying for college? Admissions officers? Are they a good target?

A preoccupation with prestige is effectively a disease - one for which a cure is not so easy. An unhealthy quest for prestige can be a family disease which is made worse by self-consciously prestige oriented schools. Prestige mongering is such an impediment to life.

An antidote is to seek first things first in the confidence that if that is done, then a lot of good stuff will likely follow.

This article was written in the hope that at least a few students and their parents might be tempted by it to grasp freedom and its benefits and to free themselves from the tyranny that goes with a preoccupation with prestige and filling in bubbles on tests.

I thank Justin Witt and Barbara Neuberger for their insightful comments.

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