

## OSSM at 25 Years: My Reflections on the Discovery Mission

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*Note: This piece was written 9 months ago in October 2017 for a compilation that Professor [Fazlur Rahman](#) had planned for the 25th anniversary of the Oklahoma School of Science and Mathematics, for which he invited me to contribute a “what have you learned” recollection piece. I learned today that the compilation is not being published after all, but may happen again in 5 years. I have chosen instead to share it here on social media, for my friends, family, classmates, alumni, educators, fellow Oklahomans, and anyone interested. Please note the vote mentioned at the end has come to pass favorably, and please forgive the horn-tooting at the end, which was meant to show achievement to reflect favorably on the school and to help further the cause of cannabis destigmatization. The photo above was taken by my Samsung Galaxy Android phone when I was flying in a seaplane over the area in and around Cortes Island, B.C., Canada.*

This year's graduation marked a milestone in the history of the Oklahoma School of Science and Mathematics (OSSM). It was the year that the school graduated its twenty-fifth class. I am fortunate to count myself as an alumni of the school--a member of the sixth class to graduate (Class of 1997). This year I had the honor and great pleasure to attend our class's 20th graduation reunion, organized by my classmates Marty Scantlen and Cherie Herren. This was a joyous event full of reconnection with old classmates and professors, and walking grounds old and new and still full of memories. On this occasion we are marking of a quarter-century of OSSM graduations, I've been graciously invited by Professor Fazlur Rahman to share some of my thoughts and ideas, both at OSSM and beyond.

### Unpacking the OSSM Mission Statement

I really was not sure how to even take on such a task. Then I found my roadmap when I went to the school website and read the mission statement. I want to reflect on that bold three-part mission statement. I have underlined some key parts. From the website, we find on <http://www.ossm.edu/our-history>, **The mission of the Oklahoma School of Science and Mathematics is:**

*To **educate students** who show promise of exceptional academic development through a program of instruction and discovery that challenges them far beyond the traditional high school model, imparting a superior foundation for careers in science, technology, engineering, and mathematics fields.*

Was I educated? Tremendously. Did I show “promise of exceptional academic development”? Well, all I can say is that I am flattered that Dr. Manning and the Admissions Committee felt so, and getting admission was itself a great boost in self-confidence to 14 year-old me, as I knew of others who had tried but did not make the cut. That boosting in confidence and feeling of privilege to be part of this school I felt even moreso this year when I returned for our reunion--showing the lasting uplifting effect of that admission decision. As an aside, I did have quite a bit of energy on my interview day as I drank an iced blended caffeinated beverage beforehand--more than I was used to! (And I'm pretty sure with all that augmented nervous energy, I offered to show my interview panel my prowess at three-object juggling!)

For me, in my 14 year-old mind, I thought more about the social privileges and niceties I would be sacrificing such as spending time with my high school friends, driving around, and having my own room and privacy. But I was excited about learning about subjects in a more rigorous fashion--math, chemistry, computing, and physics. Having had spent the previous two years in high school putting in quite a bit of time and energy doing speech and value debate, I yearned for more empirical knowledge foundations. Note the program prescribed at OSSM: “instruction **and** discovery.” It was the latter that really took me over the top -- as I discovered new subjects and ways of thinking as well as new capabilities in myself. What a wonderful mission for a school to utilize the awe and excitement of discovery to educate! Thanks to the wonderful arts and humanities programs, I actually discovered this was one of my core passions as well as chemistry.

Then there is a short but very critical bit: “that challenges them”--oh boy, was it a challenge! I remarked recently on Facebook when we were sharing old pictures from our graduation day in advance of our reunion that the smiles that my classmates and I had on our faces were the most genuine and honest smiles we had ever smiled. Many agreed. Graduation meant that we had faced and successfully met the challenge that was OSSM. No small feat! Multiple rigorous classes, projects, homework, tests, lab assignments, competitions, and so many other arts and activities and lectures to be exposed to! Not to mention the social world!

And finally, “superior foundation” for my career -- was it? Most definitely -- I was able to take more subjects and majors in college thanks to both the leg up in knowledge and studying skill that the school imparted to me.

*To serve as a **catalyst for advancing public school STEM education in Oklahoma** by providing residential, regional, summer, and virtual learning programs that extend advanced science and math education to a diverse student demographic.*

During my time, this outreach program was in its infancy. But I did have an opportunity to invite an influential teacher from my hometown of Muskogee to come and tour the school and attend some workshops. I am still in good and close contact with him, and he has gone on to become a doctorate-level professional in higher education assessment and achievement and still to this day he remembers the rigor and development of OSSM that he had a chance to witness that day. It was wonderful to be able to honor him that day thanks to OSSM's statewide mission. I know in these days of extreme austerity in the state educational budget, the satellite site educational program has been significantly curtailed from its earlier heights. Hopefully this will change as education is the key to human flourishing, and investment is essential for our collective survival and advancement.

*To inspire students to make a difference in the State of Oklahoma and the world by leveraging their knowledge and curiosity for the betterment of mankind.*

Wow, what a truly bold passage in the mission statement. 'Mankind' really ought to be retired for the gender-neutral term 'humanity'. Nevertheless, I would say that, in retrospect, the incredibly strong and durable foundation in fundamental sciences that OSSM's educational program instilled in me was a bedrock that helped me to stretch my own understandings and hold fast to my footings in scientific evidence and its implications when I had been faced in my professional work life with dilemmas relating to social development that ostensibly turned on science. And because there were few professionals in my field who were writing and speaking up about these dilemmas, when I did, those words did seem to help make some difference.

### **My Discovery Journey**

Let me explain. After graduating from OSSM, thanks to the excellent preparation and coaching I received there (mainly by the late, great Dr. Charles Roberts also of Muskogee--may the silly ol' bear rest in peace), I was bestowed the opportunity to be a member of the US Chemistry Olympiad Team, and spent a few weeks training at the United States National Chemistry Olympiad Camp at the US Air Force Academy in Colorado. While I was not chosen to be a member of the "travelling team" (though I was told my organic chemistry scores were top-ranked--kudos to you, Dr. Rahman!), the experience was nevertheless a once-in-a-lifetime opportunity that gave me exposures I would not have ever dreamed of before and also an enduring sense of confidence in understanding chemical sciences. One opportunity was getting plenty of one-on-one and small group time with a Nobel Laureate in Chemistry, Tom Cech, who discovered the bio-paradigm-shifting catalytic activity of RNA molecules. Another was a presentation by a chemist who worked at IBM

Research Labs doing synthetic organic chemistry polymer development. I even stayed in touch with this chemist and two summers later had a chance to work on an independent project in his lab and others as part of a NSF supported undergraduate research program. Make no mistake about it -- OSSM directly made all of this possible for me.

When I was a college student at Berkeley, thanks to all this prior exposure, I was able to get ahead in the chemistry coursework, shaving off one full year of coursework and being ready to take “honors” level coursework in physics and mathematics. (I also got a chance to meet another Chemistry Nobel Laureate, in my first year, Glenn Seaborg, who discovered both Plutonium and Californium, and has his own element named after him). All of this freed me up to pursue further studies in human and social sciences. First I went with Religious Studies (an interest that was initially fanned at OSSM in Dr. Lawson’s Western Civ course), which eventually became my minor. Then I made my way to the study of Philosophy, which became my second degree major. Now, in philosophy I had “my mind blown” -- I was exposed to so many ways of understanding and seeing the world, so much exploration of about the nature of consciousness and how the mind and body are inter-linked, and questions about values and meaning.

When my friends from the undergraduate philosophy club said that there might be a way to further my thoughts and understanding about mind and the nature of reality by inhaling the fumes from a burning plant, I was incredulous! But, trusting in their wisdom, and in service of the spirit of exploration and discovery, I went for it, about 2.5 years after my graduation from OSSM. It was a profound and curiosity-provoking experience for me. My sense of inner anxiousness for the first completely relaxed that day, and it was thanks to marijuana (scientific name, Cannabis) and a comfortable environment. Expected health and quality of life benefits came to me through this discovery. I found it hard to accept that this was considered unequivocally “a bad thing” when it seemed to have done such good for me. Later, understanding this paradox became a focus of my scientific and medical work.

As heretical as this was to the prevailing orthodoxy, I knew that there was something fundamental here. And though I was a bit shy of age 21 (which is now the legal age to consume in California and other states, unless you have a medical authorization) when I had the above-described experience, it was a moment of discovery that catalyzed further exploration for me. I later began to see my type of cautious explorations in this field, which actually has a name--pharmacognosy, or the “A branch of pharmacology that studies medical substances that are derived from natural sources, and their recognition”--as akin to what it would have been like 400 years ago in Europe when Galileo had just caught a glimpse of the moons of Jupiter and imagined a new celestial map, but the telescopes were illegal! Or like the 16th century founder of anatomy, Vesalius, who had to illegally sneak and exhume

cadavers from the graveyard in order to beautifully map the circulatory system. I later found out that one of the most important figures in the history of science, Sir Robert Hooke, who invented the reflecting microscope and described “plant cells” for the first time, grew and self-experimented with cannabis and described its salutary effects. So I have since reassured myself that I was and am in good company!

Thanks to the spirit of OSSM, my curiosity was piqued, and in the spirit of discovery and hope for betterment, I doggedly pursued answers. Independently, I began exploring cannabis science papers, meeting with researchers, and the words ‘cannabinoid’ and ‘endocannabinoid’ entered my vocabulary and pharmacologic worldview. This endocannabinoid system it turns out is pretty fundamental and was just starting to be elucidated in the 1990s. It plays a key role in regulating mood, appetite, memory, inflammation, pain perception, muscle tone and movement, extinction of traumatic memories, protection of nerves and brain tissue, bone growth, tumor regulation, infant suckling reward, stress management, eye pressure, gastrointestinal motility, seizure activity, and other areas of health. To show you how my thinking and ideas evolved, I’ll share a passage about a time from my final year in college from my personal statement written as part of my admission application to the Clinical Fellowship in Hospice and Palliative Medicine at the National Institutes of Health Clinical Center, the world’s largest research hospital, which I completed after my residency, in 2014-2015.

One evening in the fall of 2001, as I was returning home from the chemical neurobiology lab I worked in at the time at UC San Francisco, I came across a symposium underway in the main auditorium of my undergraduate campus’ life sciences building put on by a newly formed student group called Students for Sensible Drug Policy. The symposium, entitled “Marijuana: What D.A.R.E. Didn’t Teach You”, piqued my curiosity. I entered the symposium during the middle of a talk by Dr. David Presti, a UC Berkeley neurobiology professor who taught a very popular ‘drugs and the brain’ class on campus which I had heard about but had not taken. In his talk, Dr. Presti sketched on the chalkboard the chemical structures of compounds in cannabis known as cannabinoids, described the recent discovery of the endogenous cannabinoid signaling system, and highlighted its unique mode of retrograde signaling at neuronal synapses. I found this mode of signal transmission fascinating—it implied a kind of built-in neurotransmitter feedback system. I heard other talks at the symposium that day related to the use and production of medical marijuana, and for the first time I grasped the putative scientific mechanism of action that might underpin claims that were being made about the medical utility of cannabis for problems related to pain, nausea, and vomiting. Might exogenously administered phytocannabinoids be interacting with and binding to tissue-specific human endocannabinoid receptors thereby leading to downstream physiological effects? As I began reading more about cannabinoids and endocannabinoid

signaling, I discovered that the scientist, Dr. Roger Nicoll, whose lab had discovered the retrograde nature of endocannabinoid signaling, was a professor at UCSF whose office was in fact just a few floors up from the lab in which I worked. By analyzing the results of molecular electrophysiology experiments, his lab had concluded in a paper published in the prestigious journal Nature that: “Signalling by the endocannabinoid system thus represents a mechanism by which neurons can communicate backwards across synapses to modulate their inputs.” I eagerly went to meet Dr. Nicoll to discuss his discoveries and the field overall, and this further helped to seed my interests in this emerging area of medicine and guide my overall future clinical training path.

Again, the endocannabinoid system (ECS) is very important to life and health. The scientific director of one of the Institutes of National Institutes of Health wrote in a review article that he and another colleague published in 2013 that “modulating ECS activity may have therapeutic potential in almost all diseases affecting humans, including obesity/metabolic syndrome, diabetes and diabetic complications, neurodegenerative, inflammatory, cardiovascular, liver, gastrointestinal, skin diseases, pain, psychiatric disorders, cachexia, cancer, chemotherapy-induced nausea and vomiting, among many others.” Moreover one of the final projects in the early 2000s of the late Nobel Laureate in Medicine Dr. Julius Axelrod, famous for his fundamental discoveries on how adrenaline and dopamine are produced, stored, and used in our bodies, was on the use of cannabis compounds as powerful antioxidants and protectants of the brain from damage due to injury, stroke, and diseases such as Alzheimer's. He felt this to be so valuable that he co-patented the idea for the government.

Truly, I can say that I had a sense early on that cannabis and cannabinoid science would yield major breakthroughs in health and disease because, despite the social opprobrium this topic has unfairly shared, I knew that the chemistry was sound. I knew that receptors are specific in their binding to molecular ligands. I had and continue to have a confidence in the uniqueness of chemical structures in space binding and reacting in specific ways. This matters; this is unique; and this is something “you can hang your hat on”, as long as we humans have shared genes and plants make body-familiar molecules. It was OSSM-bred confidence in the chemistry of life that helped me to hold on and to “trust” the science throughout my undergraduate, graduate, and medical education and training.

Some achievements in this area that I am proud to share:

- I conducted the first research with state-authorized medical cannabis-using patients in the United States under NIH-issued federal Certificates of Confidentiality, recruiting 176 subjects both from a pain specialty clinic and an urban medical cannabis dispensary along with interviewing the owner, defining pain

and symptom burden and relief, health-related quality of life, and social psychological distress levels in such patients.

- My first-author 2009 review article in the *Journal of Opioid Management*, “Medicinal Use of Cannabis in the United States: Historical Perspectives, Current Trends, and Future Directions” has been cited 142 times according to Google Scholar Citations tracker, including by the UN World Drug Report and has been translated into Spanish by the Social Science Research Council and cited in several major textbooks.
- To facilitate closing the translational gap between cannabinoid medical science and clinical practice, I led the American Medical Association to call in 2009 for a review of Cannabis Scheduling in US federal code.
- My review article: “Cannabinergic Pain Medicine: A Concise Clinical Primer and Survey of Randomized Controlled Trial Results” was featured on the cover of the February 2013 issue of the *Clinical Journal of Pain*, the 8th top-ranked journal in Anesthesiology, as per Web of Science.
- A poster based on the findings of this article received a poster award at the 2013 American Academy of Hospice and Palliative Medicine Annual Assembly. I have helped develop accredited clinician educational modules based on this work.
- I also wrote an entry “Cannabis for Symptom Control” for Fast Facts and Concepts, a standard reference that provides concise, practical, peer-reviewed and evidence-based summaries on key palliative care topics important to clinicians and trainees caring for patients facing serious illness around the world. They are cross-published in the *Journal of Palliative Medicine*, and are indexed by Medline.
- I recently co-wrote a chapter in a first-of-its-kind collection, *The Routledge Handbook of the Philosophy of Pain*, on Pain and Controlled Pain-Relieving Substances in which I describe 3 "faux health science" logics: 1) euphoria pathologization 2) asocial addictionology 3) pharmacologicalism.
- And finally, last but not least, I have served as a policy adviser for many state departments of health and testified in many policy-related public hearings. An effort that I am most proud of is that I had the chance to serve since 2015 as an adviser to Oklahomans for Health, a 501c4 dedicated to the legalization of medical marijuana. They successfully drafted State Question 788 and Oklahomans will get the chance to vote on this by 2018, which will ask citizens if they favor supporting the legalization of doctor-authorized medicinal marijuana. I do believe this is one of the better written laws in the country. I am hopeful that the wide majority public support that this issue enjoys will lead to a win at the ballot box in 2018 which will improve healthcare and quality of life for Oklahomans, thus helping me fulfill the call in the OSSM Mission statement “to make a difference in the State of Oklahoma”.

Here's to a fine mission statement and to 25 more years of education through instruction and discovery for the betterment of humankind at OSSM. Pretty awesome! In order to prepare for this piece, I dug up an old article in *Chemical & Engineering News* that was published in July 1997 about the Olympiad Camp. What is remarkable is that I actually gave a quote to the journalist who wrote the piece that matches quite well with the theme of this piece. I'll close with the relevant passage here:

Sunil K. Aggarwal, Oklahoma School for Science & Math, Oklahoma City, plans to get a degree in "some sort of chemistry, probably more on the theoretical side" at UC Berkeley while also studying philosophy."

"I'm interested in philosophy because it helps to [forge] a link between what we're doing in science and how it applies" to society, Aggarwal says. "I think scientists with a good education in the humanities and arts and philosophy" will be better able to see how their research might be applied and understand its potential ramifications."

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