

Our country is in crisis - a High School math crisis. A recent Department of Education study bluntly states: "On PISA 2006, the U.S. score for mathematics literacy is below the average for all OECD countries." The US is also below average in high school science (especially in Physics) putting us at great economic risk. One generation after the Apollo program (when we led the world in these subjects), we are now in an unprecedented struggle to change our High School academic culture – and St. Dominic Savio HS and others like it may be a part of the solution.

A good background in Mathematics and Science is so important. No matter the student's goals and aptitudes, this foundation is necessary – not just to prepare them for the jobs of the future, but because Mathematics and Science are often the first exposure that students have to "abstract thinking" and these subjects help students develop an ability to think deeply into real world problems. Well taught, Science and Mathematics can be a joy, opening students eyes to the wonders of God's universe and how it works. Here students learn and discover in a way that is qualitatively different than in other subjects. As we consider St. Dominic Savio High School, and its proposed strong STEM curriculum, I would like to explore: Are all really capable of learning science and mathematics? Isn't the current approach to mathematics education in Texas public high schools good enough? Can we expect to do better at a brand new high school and what does being Catholic have to do with it? How can we challenge our kids to excel to the best of their abilities, and inspire their lifelong curiosity and desire to learn?

"My kid is not good at Math!" Those that struggle with concepts can exult in discovery, and also improve their abstract reasoning abilities. Not being "good at math," to many, simply means having trouble memorizing or being embarrassed about poor preparation. But with a variety of levels, and common sense use of computer aided instruction, all can learn. Mathematics is so varied – difficulty with multiplication tables does not consign one to torture in trigonometry. I am intrigued at how my mathematics aptitude differs so strongly in some areas. Although as an engineer I had enough course work for an applied mathematics degree, and considered myself good at math, I struggled with Vector Calculus yet aced Numerical Analysis, and I understand why. Very different sets of skills are necessary to excel at each. A student who thinks they are bad at math, may find to their surprise, that Geometry is night and day different from Algebra. Why hinder the long term development of those who struggle by not keeping them exposed each year to some mathematics, and more importantly allowing them to experience a variety of math subjects (in the supportive environment of a Catholic high school)? Four years of high school Mathematics is expected at more and more colleges and I hope that St. Dominic Savio creates "positive peer pressure" here by making four years of Math expected, and sets reasonable minimum targets. In many countries the exit exam for High School now includes some Calculus (and kids survive). At a Catholic school we expect those of different abilities to be accepted by their peers (something I clearly see at St. Theresa's school today), but we also recognize that this helps those with deep anxiety about Math and can help them fulfill their potential.

"Girls don't do Math!" Years ago, a brilliant girl at my HS surprised us when she dropped linear algebra midway through her senior year. As the only girl at that level of Math in the high school, she felt out of place, but today routinely we see women mathematicians, and know women can do well in Math and be accepted by their peers, but we may have to encourage some. At Rice, I noticed women were more likely to drop out of Engineering when they had borderline grades than men were, but we have come a long way since then and can encourage our daughters as well as our sons to do the best that they can.

"My kid won't need Math!" Math improves general reasoning. Even as early as Algebra, which all High School students are expected to learn, they begin to convert complex problems to symbols and decompose hard problems to those that are easier to solve. In Geometry they are exposed to the

rigorous “proofs” that will help the future attorney as much as it will help the future atomic scientist or philosopher. For the social scientist and economist statistics will be helpful throughout their career. But beyond the practical value of Mathematics knowledge, its real value is “learning how to think.” Once beyond the memorization of multiplication and subtraction tables, Mathematics is not about learning by rote, formula after formula. If that is our view of Mathematics, then our teachers have failed. Mathematics is learning a process of abstract thinking - I can't remember much of my High School calculus, but I can “re-derive” many of the key formulas. I can't remember all of my geometry but I can use other techniques to approximate answers, and I can rediscover much. Is Math's value remembering the formula for the volume of a cone for 20 years, or is its true value in aiding us in approaching very hard problems: decomposing, ruling out impractical answers, recognizing ways to simplify?

“Isn't the Round Rock (or Austin) curriculum good enough?” Perhaps it would be if we were an isolated country, cut off from the rest of the world; perhaps if the jobs of the 21<sup>st</sup> century did not require Math skills, but this is a different world now. Our standards should be higher than they used to be. The introduction of computer based math instruction has helped make teaching math easier; the creation of NCTM standards has helped; improvements in curriculum and materials have helped – but we set our standards little better than before. The days are long gone when simple blue collar jobs are likely to pay well enough – and we have to rise to the challenge of setting our curriculum to the level where our children can compete with those in other countries. On my team at work are engineers from Moscow, Australia, Eastern Europe, Sweden, India, Germany: and as we talked among ourselves about High Schools, I realized that our math standards are the lowest. As our children explore the solar system, the depths of the ocean, and build energy efficient buildings – who is going to be prepared for these technical challenges. US high school students have improved a little, we are no longer among the very worst of the developed countries in Math, but we can learn a lot from the leaders like Singapore.

- set clear standards
- don't clutter texts with lots of chatty examples, and don't include lots of reteaching
- focus on a few topics each semester, but do them well.
- assess narrowly whether they have learned the topics, and assess early enough
- use common sense computer aided instruction (structured web based supplemental curriculum and math activities such as “HeyMath!” are becoming popular) and computer based testing

Russia and Singapore begin multiplication tables earlier and by 2<sup>nd</sup> grade tests to make sure that part are memorized then, TAKS doesn't begin testing on that until 3<sup>rd</sup> grade (or later). Australia exposes even the lowest level “2-unit” math HS students to some basic Calculus and tests them on it in the exit exam. If you are in doubt about our low standards, find the TAKS tests (it is online) and compare it with that of Australia or Singapore (or to the Nordic countries if you can read other languages), but you can also read the studies that the Department of Education has done on this, and how to improve our nation's embarrassing High School math performance. It should be possible to teach most at least Algebra I, Geometry, Algebra II, Trigonometry and a final math elective such as pre-Calculus or introductory statistics, but what if we could find a way to get everyone to have at least 1 semester of Calculus? What if we could get more of our students to take Calculus as a Junior (nationally a surprising number of students take BC calculus as Juniors but it is not common in Texas), so they were ready to understand the concepts in Physics better, and so they were able to learn how to solve a wider variety of problems when they get to college. How about integrating some of the Mathematics and computer science curriculum together? Is that desirable? Is it possible?

“Why do you think St. Dominic Savio can do better?” Not just because I trust the parents and diocese ... with a new STEM school, unhindered by the relatively low standards of our state and

country, we have the opportunity to break new ground. A Catholic school has freedom from the baggage of over-regulation that Round Rock schools have to struggle with, but more importantly it can create a culture of success around our shared values and our shared desire for the success of all in the school. We have the ability to create reasonable (reasonably high) minimum expectations and explain these clearly to parents and students. The Math TAKS test is not just too boring (go online and try it and imagine having to sit in class day after day re-preparing for it) – but it is too broad. Narrow each assessment – test it early (at the end of the course rather than two years later) – offer refresher computer aided instruction if needed, but don't do ineffective, inefficient reteaching. In a Catholic school the administrators know that they have the support of the parents, and know that they can draw on parents for help more than in public schools. The teachers and administrators can have a bond of trust with parents and students that is grounded in our Catholic faith and values, and can focus on doing what is best for the student's learning. Even the best of the public schools have problems: Westwood uses a surprisingly small amount of computer aided instruction, and with its overwhelming size has difficulty facilitating communication among teachers about a particular student's needs. Why can't it with its huge pool of smart students offer something useful beyond AP calculus, as my High School did with Linear Algebra? Why doesn't it have more of its most advanced math students in independent study? How broad is the Westwood math team? Why do some students there disparagingly say that “you have to be Asian to succeed in Math?” Do the teachers of the less gifted students love their job as much as the equivalent teacher at my Catholic High School did? St. Dominic Savio can break out of old mindsets. St. Dominic Savio can use common sense rather than politics in course offerings. For example, I have wondered why the college board offers AP Statistics. Is this a real high school course designed to place students out of an imaginary college course? When I was at Rice, Statistics was a fairly advanced course, requiring knowledge of both probability and calculus. Do high schools which offer Advanced Placement Statistics expect that students will be grounded in probability and calculus before starting AP Statistics? Or are these schools giving in to the “AP Arms Race” and setting their students up to fail in college by offering an AP course that can't possibly prepare them for the rigors of later more advanced courses in this area (that will be needed by some economics and business programs for example). Others (e.g. AP Calculus and AP Computer Science) with more probability of long term student success can be emphasized more strongly (perhaps even saving money too). There is hope – the roughly 10% of High School students who take AP Calculus (even those who fail the exam) do better than their peers in other countries. A smaller percentage of US High School students take AP Physics and Chemistry (less than 5% for each), but those who do also do very well against their peers internationally. We have the opportunity to establish a new culture of good expectations and common sense education with the new St. Dominic Savio High School.

“What does being Catholic have to do with it?”

The development of the modern University, the fundamental western belief in the importance of reason and the value of academic freedom, the example of great thinkers, saints, scientists and mathematicians – and a belief in the fundamental dignity of every human being (even the most troublesome high school students) ... are all a credit to our Catholic Church. The great mathematician Pascal, the example of saints like Aquinas and the father of modern science “Albert the Great,” and of course the great teaching orders who taught me and millions like me over many years ... Vatican Astronomer, Dr. Guy Consolmago phrases it well: "The whole scientific enterprise really does coincide well with Christian theology. The whole idea that the universe is worth studying is a Christian idea. The whole mechanism for studying the physical universe comes straight out of the whole logic of the scholastic age. Who was the first geologist? Albert the Great, who was a monk. Who was the first Chemist? Roger Bacon, who was a monk. Who was the first guy to come up with spectroscopy? Angelo Secchi, who was a priest. Who was the guy who invented genetics? Gregor Mendel, who was a monk. Who was the guy who came up with the Big Bang theory? Georges Lemaître, who was a priest. There is this long tradition;

most scientists before the 19th century were clerics. Who else had the free time and the education to gather leads and measure star positions?" We can take pride in our Catholic faith – and be confident that our St. Dominic Savio **Catholic** High School will help prepare our children spiritually, morally and intellectually.

With God's help, with the dedication of the teachers, administrators and parents, our students can gain a lifelong love of learning, develop a set of skills that will help them in their future career, and more deeply appreciate the beautiful complexity of the universe which God created.

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