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As an Intel Semi-Finalist, I'm often asked about earlier projects and interests that motivated me to participate in a voluntary high school research experiment. When I respond that "My introduction into research originated because of two people: My father, Louis Vieni, and Brian May, the legendary guitarist of Queen" I am often met with a surprised expression. Thus, I can foresee your reaction; 'Queen, weren't they the band who does 'Fat-Bottomed Girls?' I was expecting something more along the lines of quantum physics.' Well, rest assured, the quantum physics part does come in at some point in my story, but it really isn't the most important part. And hopefully, I can try to convince you, too, that the most significant discoveries you can make in math and science need not begin with complex and intimidating physics equations. Nor does research mean sacrificing your own interests because they appear incompatible with the structure you were taught to follow when carrying out academic research. Of all the things I learned from my experience with research, I believe that this has been my most transformative discovery, and I sincerely hope that I will continue learning and continue researching throughout my life.
I have realized through my project that sometimes, the most fascinating path to obtaining the answers to your own questions begins with a little inquiry into the realms of math and science and believe it or not, the classes you took in high school are often a good place to start.

My father, a former engineer, instilled in me a relentless work ethic and drive. He always told me, no matter what your dreams are, you already possess all of the tools you need to achieve them. When you set your own ideals for the future, you are always capable of making them come true. Thus, while watching a television interview with Brian May, the legendary guitarist of Queen, I became enraptured with the idea of building my own electric guitar. After he described

how wonderful it was to construct a guitar with his father, May immediately became my idol and I set out to convince my own dad, to tackle the same project.

Thus, when I think about my Intel project, the memory merges with a vision of my father and I toiling in the summer heat, trying again and again to produce sound from the bits and pieces of electronics in front of us. This early experience with experimentation seemed like the perfect way to express my appreciation not only for May, but for my father, the engineer, as well. I never imagined that I could merge science and math with my favorite instrument in a research experiment that would ultimately prove to be one of my most prolific and enjoyable experiences.

In order to build my own guitar I clearly needed to research how I would go about the task. Thus began, unbeknownst to me, my first true application of the scientific method that would eventually inspire me to become an Intel participant. I researched multiple designs in order to create something that felt both original and practical and then I made detailed lists of the necessary supplies. I collected materials from around my house, online, and occasionally even the garbage can. I scrounged everywhere for the parts, all the while keeping within a tight budget. Sometimes I even had to create parts rather than purchase them. With the help of my own dad, I learned to create a functioning circuit, wire the pick-ups, solder the wires to the pots and capacitors, and hook up all the electronics to the input.

I spent countless hours in my garage toiling in the heat. Seven in the morning and I'd be there, surrounded by a fog of paint fumes, diligently constructing amidst my clutter of scattered materials. But that was just it. It was *my* clutter, *my* mess, which would eventually transform into *my* guitar. It was that thought, the idea that I could make something, and then use it with pride, the sense that I could call it mine, understanding the meaning of independence and self-

sufficiency, that kept me going. And the feeling would grow, as six pieces of material became five, and five became four. I was striving for that unity, that harmonious sound when multiple notes, seemingly unrelated, come together to form one beautiful chord. I was immersed in a music that I was making; my own music. A composer, I thought, I am a composer. And so I would proceed.

There were splinters, sure. There was sweat, as there is with any research project. But I persisted. I sanded and smoothed the neck to create a light, sleek instrument. I shaped and filed the frets to create the perfect tone. I precisely measured and re-measured the bridge and neck to ensure perfect playability. I had to make several prototypes on life-sized cardboard guitars before transferring my favorite design onto the new guitar with painstaking accuracy. I took great care in picking the perfect colors, glossy and vibrant shades of gold, silver, black, and blue. I even bought a wood burning kit to burn my name into the headstock. Finally, after priming and painting, I permanently sealed the wood with a polymer. Now I would have to create a functioning circuit, reflecting on what I had learned in science class, and what my dad had taught me about engineering. After much more research and trial and error, I finally perfected the circuit. The moment of truth had arrived.

Plugging into the amp was one of the most intense moments of my life. Like the scientist who fears that his findings will contradict the relevancy of his hypothesis, I thought, ‘what if a summer’s worth of work had been spent creating a malfunctioning piece of equipment?’ Thankfully, my guitar worked and my endeavors were successful. I learned firsthand how research and perseverance can be rewarding.

I hope that now it will make sense when I say that my earliest encounters with independent research were inspired by two important men, who, without a true knowledge of their deeds, unleashed in me not only a drive to pursue and create, but a means to further human knowledge through research and experimentation. I was flooded with pride at the thought of being able to use my creation for the enjoyment of others as well as myself, which is, in my opinion, the ultimate mission of scientific research. And so, thankful for this extraordinary, unforgettable experience and full of determination and creative spirit, I earnestly sought out my next new and exciting research opportunity.

I have always loved the physical sciences and have been intrigued by the way scientists in the fields of biology, chemistry, and physics, especially quantum physics, use their minds to ponder questions and discover answers about the universe. The abstract complexities of binary system quantum computers reduced to perfect simplicity and tested correctly over and over to perfection is fascinating. I always dreamed that one day I would pursue some of these sciences and discover the fundamental nature of our universe. It became my mission in life to discover these underlying patterns and ideas.

In high school, I used my resources to design a social science project. I shifted my focus towards an “economics of education” project, which would unite aspects of the social sciences with mathematics. This project fostered my scientific inquiry skills; skills I intend to use in college as I conduct research in the physical sciences and contribute to the present body of knowledge. Fortunately, my project incorporated a focus in mathematics, which is unarguably one of the essential foundations of modern science. Primarily, I focused on data and statistical analysis.

Thus, in order to conduct my research project I needed to master statistics. Encouraged by the research I had conducted on guitar models and designs, and the knowledge that I had asked my dad to show me how to create a functioning circuit, I sought help from the mathematics department in my school. I scoured the library and pestered my math teachers until I felt I had a firm understanding of the basics of statistics and modeling. I discovered a completely unfamiliar branch of mathematics and I learned it with gusto. I spent hours teaching myself the ideas and methods used in statistics and probability and I used these lessons in my Intel research.

My research focused primarily on the economics of education. I questioned the ways in which administrators allocate resources to optimize student. I needed to see if spending will have a serious impact on educational research and on the future success of American students. Administrators and politicians will always need to know how spending impacts overall learning. Because of my limited resources and time to complete my Intel project, I analyzed only high schools in Nassau and Suffolk County.

After seeing that present high school ranking systems are too narrow in scope and do not address enough variables, I attempted to include more variables and this lead me to see which schools are the most economically efficient. Schools that spend significantly lower amounts of money, yet are able to perform at a very similar level should be analyzed and studied. I showed which schools spent the least amount of money per student for the best test scores in regents, SAT, and AP exams. I analyzed all test scores versus spending per pupil and created a sample of schools picked from various “tiers” that were defined in my paper. Using different types of statistical analysis I measured relationships and correlations between my variables. From the tests I was able to conclude that increased spending per pupil did not directly influence test

scores. However, spending per pupil does indirectly influence test scores, in that spending per pupil influences class size and then class size affects student performance on state mandated tests.

In this study Regents exams in New York State were used as the primary means of measuring student performance. However, SAT scores were also considered and analyzed. I split the schools into various "tiers" based their ranking in current school rankings. The schools most often in the top of the rankings were considered "top tier" and schools most consistently in the middle and lower end of ranking systems were labeled "middle" and "lower" tier schools respectively. From the data I was also able to conclude that the various "tiers" perform significantly different on national and state level exams. On regents exams most "upper" and "middle" tier districts perform relatively the same for significantly different costs. "Middle" tier schools spend significantly less than "upper" tier schools, yet perform near or in some cases at the level of "upper" tier schools. "Lower tier" schools usually perform significantly worse in state exams. However, for SAT exams "upper" tier schools perform significantly higher than both "middle" and "lower" tier schools. Thus, it becomes necessary to measure the fundamental nature of these exams.

In order to measure the performance of the different "tier" schools I had to develop a mathematical formula. Given the tests results and percentages I had, I had to see which school consistently scored well. I had to measure not only different years of test takers, but also different tests. I needed this mathematical formula to account for differences in the student body. I needed to account for not only changes in the student body but a way to equalize the subjects and really see the impact of the variables. My formula did this while adding checks to make sure of no undefined numbers or non-real answers. My formula and the separation of

schools into tier was one of the key components of my project. This allowed me to somewhat assess tests that I did not have statistics for every school. This allowed me to expand my research despite my limited resources.

Also, my research dealt with the recent addition of a 2% tax cap in New York State. These forces schools to try to more efficiently spend money to produce the best education. The 2% tax cap mandates that no school can raise its budget by more than two percent. After a budget is actually created it actually amounts to about a 2.7% raise. However, a school can raise its budget by more than the 2% if it is able to get 60% or more of its constituents in support of the higher budget. The problem with this is that if the new budget is proposed and fails, then the school loses much of its power to even create the proposed 2% budget. Thus, schools are taking a major gamble when attempting to get a super majority vote. While most districts will be limited to a state mandated 2% raise in year to year spending, those "rich" districts that can anticipate a 60% passing rate can spend more freely. This will, in turn, create an ever-growing disparity between the wealthy schools and everyone else and all others.

Ultimately, with the help of the school report cards I was able to pin point which areas of a school have the most fraudulent waste. I saw how certain key areas of spending translated into test scores, and how efficient and accurate certain test scores were in measuring student performance. Through this new branch of mathematics I was able to see the convictions I always held come alive, though I had to step outside my realm of familiar territory to do so. I saw how certain tests and certain spending areas either had a great impact or a lesser affect on student performance. This made my project more relatable and I became more confident that the research I was conducting was valuable. This project allowed me the latitude to focus on research questions about which I wanted to find answers. The more involved I became and more

statistics I retrieved from the various districts I was studying, the project became an ongoing pursuit to discover why some school districts are limited by their economic status, while others are not; why some "relatively" poor districts are able to promote higher academic achievement than other better financed districts.

Though always interested in the topic of education, economics, and efficiency, I began to adapt a personal passion for my project. The statistical formulas were not mere math equations; they were evidence of social injustice that I felt needed to be brought to attention.

Ways to efficiently spend money must be addressed. Studying this topic will help school districts avoid budget loopholes. Parents should have access to data that could help them understand which school district is the most appropriate for their children. This will affect the housing market and the demographics of many communities. However, the most important part of this research is its effect on a student's education. Hopefully, the best schools will continue to improve, while other schools will try to duplicate, or even improve upon, the top school's teaching strategies. This will create a cycle of improvement and growth in what has arguably become a stagnant educational field. Reasons why schools that perform significantly higher on national exams, such as SATs and AP exams, perform similarly to other schools on state-wide exams must be analyzed to foster growth. The enthusiasm that I developed for this type of research has given me the confidence to continue research in my undergraduate or graduate studies and has encouraged me to pursue research continually in the future, whenever I have a personal question, want to create or express myself, or acknowledge an important issue.

To continue addressing this question, I would expand my research. I would expand the time frame of my research and include more information beyond just the past four years. For instance, while my statistical analysis of class size was certainly valuable and valid, my study

would undoubtedly be more complete if I included more variables beyond what I analyzed. In this regards my research showed me that research is a continuous process. Data must be continually collected and all information is valuable when deriving your conclusions.

My only advice for future researchers is never to quit. The moment of discovery is pure ecstasy. Even if your original hypotheses are shown to be incorrect, you have still succeeded in contributing your own interests, beliefs and creativity to the pursuit of knowledge and experimentation, a far greater success. The knowledge that you created or discovered something leads to pure happiness in that you have made some aspect of your own life more meaningful as well as significant impact on society. Never sacrifice your ideals and take the "easy way out," but rather, be all the more motivated to work harder to achieve your goals. Following the seemingly selfish desire to see your work completed is in reality the most selfless act possible. You are furthering the development of the human mind and offering important insight about our existence. Consider yourself an artist and create a new form that encompasses both your education in math and science, as well as your own personal obsessions.