2019 Worldwide Best Practices for Giftedness Conference

Keynote (Script)

"Designing Conditions for Talented Students to be Creative, Ethical, and Scientifically Minded"

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Abstract

In this keynote speech, I describe three exponential technologies affecting our present and future world and make the case for how these advances in technology require new skills that go beyond content knowledge. Following the description and illustration of exponential technologies, I paint a vivid picture of three former students of the Illinois Mathematics and Science Academy (IMSA) who can serve as icons for how we can nurture the next generation of creative, ethical, and scientifically minded persons. Through their individual vignettes, I describe how IMSA creates the conditions to nurture the most important skills and predispositions necessary now and in the future.

Introduction

Over 108,074 babies are born in the United Arab Emirates (UAE) every day. By the end of today, 300 children will be born. These children will graduate high school in 2037, if they attend 12 years of school. (And, here I would like to make the caveat that my comments relate for the most part to a North American, specifically, USA context.)

Imagine the kind of world these children will inherit….and, if they are talented students, what conditions can we create so that they become creative, ethical and scientifically minded?

Consider just three exponential technologies that are affecting us today and imagine where these technological improvements may be in the year 2037.

How do we prepare our young people for this future world?

The **first exponential technology** that I want to discuss is **autonomous or self-driving vehicles.** Already 28 states in the USA have considered 98 bills related to the general topic of autonomous vehicle.

Self-driving vehicles pick up and drop off persons in several cities, such as Boston, Pittsburgh, and Phoenix. And soon, here in Dubai!

This exponential technology, autonomous vehicles, will not only disrupt jobs (truck and taxi drivers), but it will also have implications for car insurance, for car ownership, for when, or if people will get drivers' licenses.

What about the implications for parking, commuting and suburban living?

In the UAE, under the Directions of His Highness Shaikh Mohammed Bin Rashed Al Maktoum, Vice President and Prime Minister of the UAE and Ruler of Dubai, the Dubai Future Foundation in conjunction with Dubai's Roads and Transport Authority Launched the 'Dubai Autonomous Transportation Strategy.' The strategy aims to transform 25% of the total transportation in Dubai to autonomous mode by 2030, involving 5 million daily trips, positioning the government of Dubai as a global leader.

What kind of education is needed to prepare young people for a world of autonomous vehicles?

A **second exponential technology is additive manufacturing, or 3-D printing.**

How many remember dot-printers? (No printers...Kinko's copier services).

Then, faster printers came, laser printers after that and all of us became publishers.

The impact that laser printers had on self-publishing and our office lives during our life-time will be child's play compared to the impact that additive manufacturing will have as 3D printing becomes as ubiquitous as laser printing.

Additive manufacturing technology is now being used creatively to make everything from jewelry to fashion to aerospace—they have already 3D printed jet engine parts.

You might already know how this technology is being used medically to create dentures, bones and even human organs and body parts, such as limbs and vascular systems using groundbreaking 3D bio printing techniques.

Today 3D printing advances are already achieving remarkable things how much more disruptive will this exponential technology be **by 2037**!

In October of last year, a 20-year old woman, Penelope Heller, was fitted with a custom 3D-printed sternum and rib cage at the New York-Presbyterian/Weill Cornell Medical Center.

She suffered from a rare bone cancer.

What if every person on the planet, no matter their country, socio economic status, political affiliation everyone in the world, had a powerful 3D printer that could print: clothes, food, currency/money, body parts, weapons? What are the ethical implications of 3D printing?

The last **exponential technology** that I want to mention is **Artificial Intelligence or AI**. AI will challenge our ethical systems now and in the future and has become quite popular thanks to Hollywood and the media among other reasons.

You may know **Jarvis** (from Iron Man).

Jarvis (stands for **Just A Rather Very Intelligent System)** is a highly advanced computerized AI developed by Tony Stark, to manage almost everything, especially matters related to technology in Tony's life.

AI is gaining traction as the Internet of Things grows.

IoT is the merging of hardware (i.e., appliances) with sensors connected to cloud services that exchange data. Think Alexa, Echo, TESLA cars!

And to show how reality sometimes mirror science fiction, let me tell you about Mr. Zuckerberg.

In 2016, Mark Zuckerberg, Facebook founder, built his own version of an advanced AI.

He called it "Jarvis" to run "my home and help me with my work."

Have you heard of the AI robot that passed a college entrance examination?

The Todai Robot was able to write a 600-word essay on maritime trade in the 17th century that was good enough to meet college entrance criteria.

Noriko Arai, AI expert and member of the team that built the robot, explains in her TED Talk that this wasn't because it possesses intelligence, but rather because it recognizes key words.

"Our robot took the sentences from the textbooks and Wikipedia, combined them together, and optimized it to produce an essay without understanding a thing," Arai says.

What can Todai Robot not do: discover, create, find meaning, think ethically.

What knowledge do we teach our students in a world where Google knows everything?

What skills do we teach our youngsters given our future world; I would argue our present world?

What do our children need to learn now for a future that is exiting, frightening, and unpredictable?

Three weeks ago in a Feb 18, 2019 article in Gulf Education title, "How to use AI for an immersive learning experience," the article looked at how we can best use AI tools to enhance student learning outcomes.

Again, here the UAE is a leader.

In October 2017, the UAE became the world's first nation to have a Minister of State for Artificial Intelligence (AI). Education is one of the key sectors in the government's new AI strategy, and the goal is not only to reduce costs but also to enhance the desire among students to learn.

In the article, Aparna Verma, Founder of Clarion School, cautions that teaching AI or being ready for the future won't be about equipping schools with fancy tech toys or pushing in coding programmes. "We believe the role of a school should focus on developing a child's toolkit to learn, a desire to learn and an enjoyment of the process of learning."

"Simply put, let us not give our children a few fish but teach them how to fish."

I would go further, I would say that we need to provide our children with the fishing pole, the fishing nets, and the fishing tools to actually fish. It is not enough to teach them how to fish… We need to provide them the tools, as well.

And in case you don't get a sense of urgency imagining the world of 2037 for children born today, let me remind you that the class of 2031 is already in our schools.

They're today's kindergartners.

Transition #1:

In the next 20 minutes or so, I hope to paint a picture of three people who can serve as icons of how the conditions we created at IMSA helped them to become creative, ethical, and scientifically minded.

Thank you to the Hamdan Foundation, the World Giftedness Center…— and good morning everyone.

Salaam alaikum!

I am delighted to be here to support your commitment—our commitment—to *develop*, *empower* and *advance* talented and gifted young people throughout the world.

Your work as an organization and as leaders, role models and mentors for the next generation is so important.

Let's give them a hand for their work!

The Illinois Mathematics and Science Academy (IMSA) was founded over 30 years ago as a pioneering community designed to serve academically talented students with an interest and passion for mathematics and science by serving as a learning laboratory in the state of Illinois.

Our mission is to ignite and nurture creative, ethical, scientific minds that advance the human condition. We pursue our mission in two ways: by serving 10th through 12th grade Illinois students through a residential academy that offers inquiry based education and college level courses and by providing professional development through curricular and outreach programs to educators and students. We also have focused on entrepreneurship and innovation, and makerspace education to increase the tech talent in the Chicago region. This year IMSA was rated #1 as the best public high school (out of 25,000 high schools) in the USA by Niche.com.
My topic today is "Designing conditions for talented students to be creative, ethical and scientifically minded."
As I prepared to come to Dubai, I mentioned to my President's Student Advisory composed of a dozen or so current IMSA students that I was coming here to speak on this topic and casually asked them to help me further understand what conditions we created at IMSA to help them develop into creative, ethical, scientifically minded individuals? Their answers reaffirmed much of what I had considered and added to my understanding of these conditions. I have included their input into my speech today.
While IMSA has nearly 6,500 alumni, this morning I want to tell you about three of them to illustrate these conditions.
First, Terez Ivy is from East St. Louis, Illinois, one of the most economically and educationally impoverished regions of the country. Today, Terez leads new product design and systems integration for a leading Department of Defense Contractor in Washington, DC.
Second, Lynn Sosa is from Chicago and first applied to IMSA 3 years after Education Secretary William Bennett called the Chicago Public Schools the "worst in the nation" (1987). She graduated from Harvard Medical School and today is a physician working in public health in Connecticut.
Finally, Sabrina Gonzalez Pasterski is from Chicago. She graduated from IMSA in 2010, enrolled at MIT, graduated as the first girl to win the MIT Physics Orloff Scholarship award, receiving the highest overall GPA: 5.00 and is currently enrolled at Harvard pursing a PhD degree in high energy physics. She has already received job offers at NASA and also at Blue Origin, from Jeff Bezos, Amazon founder.
I wish I had a hologram to introduce you to these three…perhaps at next year's conference… For now, their pictures will suffice…

As you meet these three and consider how we can nurture the next generation of creative, ethical, and scientifically minded persons, keep in mind Eric Hoffer's assertion,

"In times of change, learners inherit the earth, while the learned find themselves beautifully equipped to deal with a world that no longer exists."

#1 Illustration / proof:

Let me introduce you to Terez. This is where our hologram would appear. For now, his picture when he was at IMSA and now as an adult.

Terez grew up in East St. Louis, a city marked by poverty, violence, and lack of educational opportunities.

As you listen to the words written by **Terez Ivy**, ask yourself, "who daydreams like this?" *"I daydream of speeding through unknown galaxies to discover planets unknown. I travel to the ends of the universe, observing its simple yet beautiful extra-vagancies… I master the beautiful and delicate intricacies of time and space. I explore the most intriguing and mystifying forms of a star, a 'Blackhole'… becoming the greatest scientist there ever was."*

That question again, "Who daydreams like this?" Terez does.

Terez wrote these words on his admissions application to IMSA when he was 13 years old—and academically talented in mathematics and science—living in East St. Louis. He was a daydreamer and his hobbies were modeling and designing high speed aircraft. He was the youngest member of his high school freshmen class and he applied to IMSA: "for the experience of going beyond the ordinary and of crossing over the threshold to the extraordinary."

When I last spoke to Terez he said that: "going to IMSA was the coolest period of my life" and he said, "I'm presently surrounded by technocrats and successful people in Washington, DC—but the smartest people I've ever been around were at IMSA—and that includes the faculty and staff." Now that's a pretty bold statement considering that Terez is currently working as a software engineer at CACI, a Defense contractor with over 16,200 employees in 120 offices worldwide.

Terez found this to be true—that he learned how to think—not to just "spit back" the facts, but to develop self-confidence in offering his opinions to others. He also thought it was a tremendous opportunity to listen to the late Dr. Carl Sagan, a writer and scientist, during a special event of the IMSA Great Minds Program.

Living and learning with people from different cultures was a breakthrough experience for Terez who had lived in an almost exclusively African American city. He embraced the racial, ethnic, geographic and socioeconomic diversity of IMSA's student body and the diverse perspectives and ideas he encountered. He fully embraced the high expectations and rigor of IMSA and went as far as he could; saying his world view and sense of self was forever altered in the process.
Condition that we designed at IMSA to help Terez become a **creative**, ethical, scientifically minded person.

1. Academically: classes are designed to broaden perspectives: history of philosophy, graphic novels, and MSI
2. Non-academics are as important. For example, Clash of the halls -close community incentivizes community. Have to be creative to win. Incentive in a fun way.

Additional academic conditions include:

- Loft by science wings fosters collaborative problem solving
- Forced collaboration; group projects; problem sets;
- Creativity in regular classwork: biology classes, engineering, SIR; open ended assignments that allow you to be creative in solving problems.

While non-academic conditions include:

- Wing: belonging activities foster creativity (dorm structure)—student life
- Faces of IMSA exhibit fosters creativity and diversity (and other library art displays)
- Access to club chartering
- Leadership Education And Development (LEAD) applying creativity to solve real world problems
- Infrastructure to be creative: open spaces, makerspace, IN2, study rooms, the Loft with lots of white boards, arts and writing clubs, CAD club

Moreover, the Great Minds Program, performance arts, world languages all contributed to making IMSA the "Hogwarts for Hackers" as Wired magazine printed in May 2013.
#1 Premise: As we leave Terez's hologram, and move on to the next icon, I want to emphasize that Terez serves as an example of **creative**, ethical, scientific individual.
He demonstrates some of the most important skills and predispositions necessary now and in the future:

- Divergent Thinking
- Complex problem solving--critical thinking
- Creative thinking

Transition #2: In a world where labor cycles are accelerating, the question is, what are the foundational literacies, competencies, and character qualities that we need to teach the next generation so that they can keep pace? To address this, some schools have started teaching coding, AI, and other skills relevant to the technologies of *today*. But technology is changing so quickly that these new skills may not be relevant by the time students enter the job market. In fact, in Cathy Davidson's book, Now You See It, it states that **"65 percent of children entering grade school this year (2011) will end up working in careers that haven't even been invented yet."** So, what do we teach? How do we nurture the next generation of creators? I propose to you that the most important jobs of the future in addition to requiring people who can "discover and innovate" will also require an ethical mindset.

#2 Illustration / proof: Consider that earlier this year, scientists in China participated with the first gene-edited babies in our history. What ethical considerations went into deciding to edit the genes of a child?

Let me introduce you to our next icon—our icon of a creative, **ethical**, and scientifically minded person --**Lynn Sosa**—

Again, I wish I had a hologram to show you Lynn! But I have her picture!

The first time she applied to IMSA, as an 8th grader, (a year earlier than most applicants), Lynn was not admitted. Undeterred, she applied again and was admitted. For Lynn, a Chicago magnet school student, science was always a "natural interest." She attended IMSA's Summer Ad'Ventures program, calling it a "key learning experience," adding, "I could see IMSA was a different place."

She enjoyed the social setting and saw IMSA as a great opportunity to "fit in to a peer group of like-minded students" and sustain relationships with other talented students. Attending magnet schools in Chicago had constrained her opportunities to interact with academic peers beyond the school day. The residential nature of IMSA was compelling to Lynn. At IMSA it is cool to be a Geek!

At IMSA, she loved the array of science classes citing Microbiology as most influential. She felt that she was not the smartest kid, but learned the value of evaluating herself and her abilities. During our conversation, Lynn said that her most important lesson, which followed her to Loyola University and then Harvard Medical School was this—

"Know what you know; Know what you don't know, and Know who to ask when you don't know."

"I had early experiences doing hands-on lab work in the field and ended up loving it," she said. Lynn said, "I am still running Gram stains that I learned at IMSA, and even now, still love it." She also took Pathogenic Microbiology at IMSA which fostered her interest in infectious diseases: "Patho was really cool, and I could see myself doing it."

After IMSA, Lynn pursued her study of infectious diseases at Harvard Medical School and had a fellowship at the Connecticut Department of Health, where she now works. After residency, she realized "public health made sense for me…I wanted to make a difference." At IMSA, we call this fulfilling our mission statement "to ignite and nurture creative, ethical, scientific minds that advance the human condition."

Today Lynn is the director for the Tuberculosis and Sexually Transmitted Diseases Program at the Connecticut Department of Public Health and is also the Connecticut Deputy State Epidemiologist. Lynn's Division also handles: immunizations, foodborne outbreaks and special situations like their Ebola response activities. Lynn credits IMSA with preparing her for how to learn and for Harvard Medical School where, like IMSA, "I was in charge of my own learning." She said the IMSA classes in which she was most successful "forced me to apply my own learning on papers, problem sets and in labs…labs forced me to do it for myself, rather than listening to lectures. I learned by seeing how it works. I realized this is how learning happens."

Conditions that we designed at IMSA to develop Lynn as a creative, **ethical**, scientifically minded person:

1. Living in community fosters ethical mind—help others; live on campus your held accountable to treat people well
2. Mandatory programs; Tales from the Home Front, Ethics for Juniors (facilitated by seniors; peers teaching peers), Hall programs

Additionally:

In classroom experiences:

- Trapezoid / round tables incentives for collaboration
- Different perspectives and ideas of learning
- Academic focused environment (teachers with high degrees, motivated students) sets an expectation for mature behavior and thinking.
- History courses

- Scientific ethics in Methods of Scientific Inquiry (MSI)

Out of classroom experiences:

- Students all want to make the world better. We share ideas to explore how to advance the human condition,
- More freedom puts emphasis on making ethical choices
- Diverse communities: hearing difficulties in people's pasts
- Service learning—200 hours required for graduation-150 off campus
- Programs to engage students to learn about others' experiences

To summarize, we believe that what happens between 4 pm and 8 am is critically to development of our student's ethical mindset. Belief statements about living in community…

- All people have equal intrinsic worth
- All people have choices and are responsible for their actions
- Belonging to a community requires commitment to the common good
- Diverse perspectives enrich understanding and inspire discovery and creativity
- We are all stewards of our planet.

#2 Premise

As Lynn's hologram vanishes remember her as another icon of a creative, **ethical**, scientific mind!

Transition #3

A key area that we must be vigilant with, especially you in the UAE where 98% of residents are on Facebook and 81% are on You Tube is our tendency to have too much screen time. If we are going to prepare the next generation of creative, ethical, scientifically minded persons, we must create the conditions for them to engage in deep work.

Cal Newport author of the book, Deep Work: Rules for focused success in a distracted world, argues that **focus** is the new I.Q. in the knowledge economy.

And those individuals who cultivate their ability to concentrate without distraction will thrive.

In Deep Work, Cal argues that one of the most valuable skills in our economy is increasingly rare—the ability to think deeply, concentrate, and focus.

Deep work is the ability to focus without distraction on a cognitively demanding task.

It's a skill that allows you to quickly master complicated information and produce better results in less time.

Cal says that deep work is like a **"super power"** in our increasingly competitive twenty-first century economy.

So what is deep work?

Work that is exhausting since it demands your full time and focus; also deeply rewarding professional work that requires your full attention; it pushes your abilities, both analytical and creative, to their maximum.

Shallow work, on the contrary, is work you can do automatically, even while you are distracted. It doesn't ask much of your attention and results in little new or valuable contributions.

Deep work is meaningful, fulfilling, and creative—

It's a skill required to be competitive in the future.

#3 Illustration / proof:

The final hologram that I would have liked to appear before you today is that of our final icon of a practitioner of this Deep Work: Sabrina Gonzalez Pasterski.

Sabrina is another icon of a creative, ethical, and **scientifically** minded person.

Sabrina is known as the "Physics Girl" and is an IMSA 2010 graduate.

The opportunity to take flight lessons when she was nine helped spark her interest in science.

By the time Sabrina was 13, she had learned how to fly a plane, built her own aircraft, and flown it solo.

At 14, Sabrina flew a plane, whose single-engine plane she rebuilt, across Lake Michigan.

In response to her increasing number of achievements, her IMSA mathematics professor, Dr. Micah Fogel would ask her, "What have you done lately?"

Since graduating from IMSA, her academic career has similarly taken flight.

She originally dreamed of building space crafts and working for an aerospace company. But when she started interning for Boeing Phantom Works and NASA's Kennedy Space Center while she was a student at MIT, she realized she'd rather learn more about the physics behind flight.

She earned an undergraduate physics degree from MIT in three years with a perfect GPA. She was also the first woman to graduate at the top of her undergraduate MIT physics program in 50 years and is now a Ph.D. candidate in physics at Harvard's Center for the Fundamental Laws of Nature.

Sabrina is studying the nature of gravity and space-time—essentially working to clarify our

understanding of how the universe operates.

Her first academic paper was accepted by the Journal of High-Energy Physics within 24 hours of submission.

Her second paper was recommended as an editor's suggestion in Physical Review Letters –

And a paper she wrote on asymptotic symmetries and electromagnetic memory has already been added to Harvard's grad-school curriculum.

Awards and honors include:

She has been recognized in 2015 by Forbes' as "the next Einstein" and in 2012 by Scientific American's "30 under 30."

In 2016, Stephen Hawking cited her 2015 paper on electromagnetic memory and was said to follow her work.

Additional honors include:

2015, Granted academic freedom from her Doctoral Advisor based on her 2014 discovery of the "spin memory effect" which may be used to detect or verify the effects of gravitational waves

2016, Marie Claire Young Women Honors Recipient: "the Genius"

2016, MIT Physics 'Rising Star'

2017, Forbes 30 under 30 All Start Alumni

2018, Albert Einstein Foundation Genius 100 Visions Project—"one of the 100 greatest innovators, artists, scientists and visionaries of our time"

2018, TIME Inc, Instyle Badass Woman

Finally, three weeks ago, on February 22, 2019, we saw Sabrina's "launch" of her first book, literally.

To celebrate the 100th anniversary of the publication of Einstein's General Theory of Relativity, a publishing milestone was reached by collecting the visions of the 100 greatest innovators, artists, scientists and visionaries of our time in the world's first 3D-printed book – *Genius: 100 Visions of the Future*. Sabrina is one of the contributors to this book.

The launch was part of the Nusantara Satu Mission on Falcon 9 a SpaceX rocket.

Conditions at IMSA that helped to ignite and nurture this creative, ethical and **scientific** mind, included:

1. Lab-based curriculum teaches scientific practices in collaborative environments. Scientific Inquiries (SI) provides foundation in multiple disciplines
2. MSI-one of the best classes in any high school. Semester long research project of our choice
3. SIR given opportunity to get hands on experience onsite of school or at university, national lab, etc. SIR develops and promotes scientific thinking. Resulting in IMSALoquium. Embedded in SIR, is our modified schedule.

Non-STEM classes:

- Humanities classes incorporate science in lesson planning; gives context for application of STEM to real world;
- Intercession allows us to try out our interests not necessarily academic based;
- Learning about impact of STEM in the world through clubs and classes; Different clubs like scholastic bowl;
- Gaining access to successful alumni and people who motivate us at convocation;
- Most teachers have PhDs or master's degrees in their field; they bring high levels of understandings.
- Academic freedom; teachers can make innovative curriculum; independent study;

A passionate teacher and a passionate students especially in math and science is the perfect combination to create the conditions to develop creative, ethical, scientific mind A student mentioned to me that in the halls there may be a student who slides down the banister of the stairs and together with her peers might consider the physics of sliding down, the effect of friction and the effect of slope on you, etc. That would never happen anywhere else!

Conclusion #3

And with our last icon, Sabrina, the scientific thinker with the super power of deep work and focus, our hologram vanishes.

The bottom line is we need to ignite and nurture creative, ethical, scientific minds…because, we need to

- Prepare students for jobs that don't exist
- Using technology that has not been invented
- To solve problems we have not yet confronted

Conclusion

As I wrap up, let me say one final word.

For my speech, I separated conditions for each of the domains, i.e., creativity, ethics, and scientific thinking, yet my students were adamant to state that all 3 areas interact and intersect with each other.

As an educational community, you and I can create the conditions and organizational culture that celebrate hard work, development and resilience.

Albert Einstein said, "It's not that I'm so smart, it's just that I stay with problems longer."

Let me end with our philosophy at IMSA coined by our founder, Dr. Leon Lederman, who won the Nobel Prize in Physics for his discovery of the muon neutrinos. He had a key role in the discoveries that broadened the understanding of subatomic particles that are considered the building blocks of the universe. He had key roles in discovering two subatomic particles — a neutrino and a quark — which greatly enhanced scientists' knowledge of the composition of matter.

He said,

If we do what we know and feel is right, it is bound to happen that among our graduates there will be numbered scientists, engineers, and those who go on to earn degrees in law and letters. There are likely to be those few who create new intellectual worlds, cure a dreaded human ailment or in some other way significantly influence life on our planet. Our philosophy will be to treat our charges as if each one is capable of this extraordinary achievement. Only one such product will make the effort and expense of this school for its entire duration worthwhile.

Thank you!

On behalf of IMSA, I would like to give this book on American Scientists written by IMSA students and edited by Dr. Lederman and Dr. Scheppler to Dr. Almehairi.