FIRST IN THE WORLD CONSORTIUM
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Thank you Paul and good evening.

Paul asked me to talk about the current state of thinking in mathematics and science education and I will honor his request; but because you are captive for a few minutes, there are a few other things I would like to say because you represent a critical mass of the strategic leadership in this consortium.

There is a poignant story/poem found in a book of story/poems written by Brian Andreas that puts into context some of the thoughts I want to share tonight, and it read as follows:

> "There are your fog people and your sun people," he said.
> I said, "I wasn't sure which kind I was."
> He nodded, "Fog will do that to you," he said.

Perhaps because I have just recently had a milestone birthday 30, the search for clarity has become a driving force for me.

So, in light of this search of clarity, I would like to pose two (2) questions and then put forth for your consideration and reflection my responses.

What is the 1st in the World Consortium trying to do and what are we doing it for? Before I respond to these questions, however, let me try to address Paul's inquiry about the current state of thinking in mathematics and science education.

You will recall that in 1989, the National Council of Teacher's of Mathematics issued what is now referred to as the NCTM standards.

These standards set forth a coherent set of benchmark criteria for evaluating mathematics curriculum and student achievement.

These 54 curriculum and evaluation standards divided into three (3) grade level groups -- specified the mathematical content and concepts necessary for higher levels of mathematical literacy, the mathematical processes required for genuine mathematical understanding, and the technological skills necessary to engage in mathematical problem-solving.

The foundation for all of these standards were five (5) student goals that reflected our nation's heightened awareness of and commitment to mathematical literacy for all students.

The goals were:

1. That students learn to value mathematics.

2. That they become confident in their ability to do mathematics.

3. That they become mathematical problem solvers.

4. That they learn to communicate mathematically.

5. That they learn to reason mathematically.

These goals established the argument that students must be exposed to many and varied interconnected experiences that encourage them to value the mathematical enterprise, to develop mathematical habits of mind, to solve complex problems and to understand and appreciate the role of mathematics in the human experience.

What is important about these standards is that they do not emphasizing a formulaic or algorithmic approach to mathematics.

Rather, they foster the development of mathematical power and what has been called a mathematical cast of mind (KRUTETSKI in Gallagher Teaching the Gifted Child, page 112). And this is an essential construct of a mathematics for us, because I am concerned that our students may become superb mathematical manipulators and not develop mathematical power.

Mathematical power is an individual's ability to explore, conjecture and reason logically as well as the ability to use a variety of mathematical methods to solve new and non-routine problems.

It is based on the recognition that mathematics is more than a collection of concepts and skills to be mastered but also includes methods of investigation, reasoning and communication.

The importance of mathematical power is that it leads to the development of self-confidence and dispels the pervasive and harmful myth that mathematics is the illusive province of a gifted few.

When teachers, parents and students themselves discover that all children can do mathematics, they become empowered with a self-confidence and esteem that makes other things possible.

According to Richard Fynam, "Mathematics is a profound and powerful part of human culture; if you want to understand nature, you must be conversant with the language with which nature speaks to us." (Mathematics Science Education Board: *Everybody Counts*, page 33).

The science community has also put forth standards, aptly called the National Science Education standards.

These standards will be published in January.

Within this document, standards are recommended in six (6) areas. These include: teaching, professional development, assessment standards, content standards, program standards, and what is called system standards. Although more comprehensive than the mathematics standards, which emphasize largely content and assessment, the four (4) goals emphasized in the science standards reinforce similar commitments. These goals include:

1. That all students use scientific principles and processes appropriately in making personal decisions.

2. That all students experience the richness and excitement of knowing about and understanding the natural world.

3. That all students have access to science to increase their economic productivity.

4. That all students engage intelligently in public discourse and debate about matters of scientific and technological concern.

Although for many students in our nation, these standards are a long way from impacting the curriculum they receive, what is exciting is their clear articulation of the need for developing deep mathematical and scientific understanding.

These standards do not endorse science for all students - they speak to science by all students.

There is a new national science initiative of which you should be aware because the originator is right in our own backyard, Leon Lederman.

Several weeks ago, Dr. Lederman convened a group of scientists and science educators to consider how to take advantage of the opportunity for change provided by the National Standards movement and the fact that both New York City and Chicago have stated their intentions to establish a three year high school a math and science requirement for all students.

As a result of this commitment, Dr. Lederman convened the head of the National Academy of Sciences, the National Research Council, the National Association of Teachers of Science, and members of the Math and Science Academy, the Teacher's Academy of Science as well as the Fermi Lab staff.

This group called ARISE which is the acronym for American Renaissance in Science Education, concluded that the traditional order of subject matter - biology, chemistry and physics, should be reversed and should include strong links among the disciplines.

It is believed by members of the scientific community that the current sequence of science does not allow for developmental understanding of critical science constructs and that this revised sequence builds upon the natural order of scientific understanding. This, of course, will require a drastic reform in content, new teaching materials, new assessments, new laboratory experiments, etc.

Dr. Lederman is now seeking financial support for this initiative and I suspect that he will be successful.

It is no secret that although many of our students and others like them consistently graduate with presumed disciplinary mastery, there is mounting evidence that suggests that they also graduate with thinking characterized by stereo types, misconceptions, unexamined assumptions and rigidity held algorithms that do not enable them to achieve genuine understanding.

Programs, even rigorous ones, that emphasize information accumulation and content mastery, do not adequately prepare children for creative and critical problem finding and resolution and for developing interdisciplinary approaches to thinking and learning.

We know that it is possible to get an 800 on the SAT mathematics examination and a 5 on the AP physics exam and still not fundamentally understand basic concepts of the physical world.

Because the context of knowledge acquisition defines the way we learn things, we need to make sure that our educational environment promotes active student engagement in their own learning.

The students in this Consortium have been extremely successful on traditional measures of achievement. Because of this, we can not let ourselves be mislead to believe that high achievement on mathematics and science exams automatically equates to deep understanding of mathematics and science and that when confronted with a problem that they have never seen our students will know what to do.

The famous Harvard experiment is a disquieting one. Despite the high AP, SAT, and ACT scores, when Harvard graduates were asked to explain why seasons occurred, they reverted to what Howard Gardner has called the 5 year old mind; the same misconceptions that they understood as very young children, they still held.

It has now become clear that a genuine understanding of mathematics and science is encouraged in communities and classrooms that enable students to experience greater rigor, coherence and **complexity** in what they are learning, that enable them to interact on deep intellectual levels, that enable them to foster collaborative and dynamic approaches to learning, and that enable them to develop integrative ways of knowing.

I believe I mentioned to you last time that a colleague of mine in Scotland, Dr. Cameron Harrison, frames our question in a unique way when he says, "I have formed the view that whatever the ultimate source of exceptional performance, it is the result of exceptional learning, therefore," he says, "I prefer to address the question, how can we best produce exceptional learning?" - And this, of course, is our challenge.

This brings me back to my two (2) original questions. What are we trying to do and what are we doing it for?

As you know, the mission of the Consortium is to ensure that all of our students achieve exemplary levels of mathematical and scientific understanding in international comparisons.

Because this is the first time that anyone in the national educational community has had access to the evaluation instrument that has been used to judge its performance, we will use the Third International Test in mathematics and science as one benchmark to see just how well our students achieve on examinations reportedly designed to measure high levels of content and skill attainment as established by an international panel.

However, we have made it clear from the beginning, that the test is not the end point for our Consortium. Rather, it is the beginning of substantive research, evaluation and sharing of curricular, assessment, instructional and organizational practices that ensure exemplary levels of mathematical, scientific, and technological understanding.

Our goal is to create opportunities for exceptional learning in mathematics and science for all our students.

Contrary to popular opinion, mathematics and science are <u>not</u> antiseptically rational disciplines. Rather, they are universal languages of patterns and relationships that allow students to enter into a conversation with the universe that is simply not possible without it.

And this leads us to the last question. What are we doing this for?

Several years ago, I read a disquieting book entitled *The Whale and the Nuclear Reactor*.

The book opened with a description of the Los Alamos Nuclear Reactor juxtaposed against the backdrop of the spouting of a majestic blue whale. The author's use of language made the reader picture both of these phenomena, one natural and one man-made, simultaneously.

The thesis of the book was that unless we are careful we will exist in a state of what the author called, "technological somnambulism", sleepwalking our way through the technological era.

The power of technology is all around us but whether or not we will use it to better our planet is still unresolved.

I remember one particularly poignant chapter in the book and that was the author's description of the technological design and social intent of a strip of highway called the Robert Moses Causeway connecting Manhattan to Long Island and Jones Beach.

This was particularly provocative for me because I grew up in Long Island and I knew of the Robert Moses Causeway.

While in its day it was heralded as a major engineering feat, it was, it turned out to be, a sophisticated structure for social engineering.

The Robert Moses Causeway was built with underpasses that did not allow the use of public transportation. This meant that buses from New York City could not travel to Jones Beach.

Having lived in New York City for the first 8 years of my life and then moving to Long Island I wondered why it was that I never saw any buses or any black families at Jones Beach.

The realization that it was intentional was sobering.

The message of this story is that mathematical and scientific competence must be tied to mathematical and scientific morality. Devoid of the human context, math and science can become tools of division rather than peace and promise.

So we are back to the question, <u>what are we doing this for</u>? Is it only to prove that we can be number one (1) in the world in the Third International Mathematics and Science Study? Is it only to prove our students can achieve high test scores? It is only to show that our kids have mastered more content than any group of students in the world?

The answer to each one of those questions is no.

We want our students to demonstrate conceptual mastery and understanding of mathematical and scientific constructs and we want them to do so at internationally competitive levels.

But our fundamental commitment, I hope, is that through the development, design, implementation and evaluation of best practices in curriculum, instruction, and assessment, the learning environment we create will reflect the values cherished by mathematicians and scientists - imagination, curiosity, creativity, invention and the spirit of healthy questioning.

So we do this for the children whose lives will be shaped by the language of mathematics, science and technology. They need to be conversant so that they can be active, equal and dynamic participants in the creation of the world they will inherit.

We do it for the adults they will become so they have access to skilled career opportunities that require more and more sophisticated understanding and use of technology.

We do it for our nation whose moral leadership in science and technology is essential and we do it for the global community because our lives are extricably connected.

The children in this Consortium will be the leaders of the next generation. We want them not only to possess the highest level of understanding and skills in mathematics, science, and technology, but also the highest levels of compassion, ethics, and morality to use what they learn for the betterment of humankind and the public good.

The Superconducting Supercollider which Illinois and the nation lost several years ago was not lost because of political ineptitude.

Rather, it was a lack of knowledge and awareness of how understanding the origins of the universe could in fact lead us to greater understanding of our own humanity.

As a result of the SSC, the physics community is not spending more money on lobbying rather they are spending more resources on education, knowing now that policymakers need to understand how the mysteries of science can unlock the mysteries of the human experience itself.

But there is one more reason that we do this and we spoke about this last time. A consortium of schools in East St. Louis would likely not have attracted the attention that this Consortium has, so we do this for those without a voice. What we learn will be shared so that all students in Illinois may learn from our experience.

"There are your fog people and your sun people," he said.
I said, "I wasn't sure which kind I was."
"Fog will do that to you," he said.

Thank you for your kind attention. I want to thank you in advancement for the work I know you will do and the support I know you will give us and I hope you are excited as we all are of the journey that lies ahead.