Are high schools teaching science backward? BY DENNIS PIERCE, July 26th, 2016

This simple change could transform STEM achievement, and New Jersey is the proof

U.S. high schools are teaching science in a backward sequence of courses that is a remnant of 19th century thinking, says former Harman executive and New Jersey Teacher of the Year Robert Goodman—and changing the order in which science courses are taken and the way they're delivered can lead to profound differences in both STEM interest and achievement.

Goodman was speaking July 22 at the Building Learning Communities (BLC) conference in Boston, organized by education thought leader Alan November. He talked about how he taught algebra-based physics to ninth graders near Newark, N.J., most of whom came from poor families—and many of whom went on to take (and pass) the AP physics exam. His approach was so successful that it has been replicated across the state and in countries around the world.

Goodman himself never took any science beyond biology in his own high school experience. Needing to fulfill a science requirement at New York University, he took a physics course because it was the only class that fit into his schedule."About two weeks in, I fell in love with physics," he said. "For me, it was the thinking activity that was involved. We don't pay enough attention to that in schools—that thinking is an activity by itself."

Goodman ended up transferring and earning a physics degree from MIT. He went to work for Harman Consumer Group, a division of the audio electronics firm Harman International, and ultimately became its president. After 20 years, he decided to launch a second career as a high school teacher.

In 1999, he was asked to launch a pre-engineering program for Bergen County Technical High School, which at the time was a brand-new vocational school. The program he headed up began with 16 ninth graders.

Although Goodman had been assured they all knew algebra, it turned out only three of the 16 had taken Algebra I. Because algebra is foundational to engineering, he used his two hours of vocational time each day to create what he called an "on-ramp" to STEM success, consisting of 40 minutes of Algebra I instruction, 40 minutes of algebra-based physics, and 40 minutes of engineering.

Why physics? It's required for almost all STEM career paths, Goodman said—more than any other science subject. "It makes science make sense," he noted. Yet, less than a third of U.S. high schools even offer physics instruction—and most students (and especially poor and minority students) aren't exposed to it.

What's more, teaching physics to high school freshmen allowed them to see practical uses for algebra and apply those skills to solving real problems right away.

As it happened, that was a huge benefit, because it answered the "why" question at the heart of so much of U.S. education. Once Goodman started teaching physics to ninth graders, he no longer heard kids say, "When am I ever going to use algebra?"

The classroom that Goodman was assigned to had no desks or tables, only a few computer workstations, because it was assumed the students would be using the space

to build things. So, before classes began that first year, he took some of the small round tables from a faculty lounge and rolled them down the hall to his room. He also took some chairs from the cafeteria.

"It was by pure chance, and not any desire to follow Vygotsky—but it turned out that I had created a social constructivist classroom," he said. "I taught them some content briefly for the first few minutes of class, and then the students applied this content to solving new problems they hadn't seen before, working together in small groups."

He added: "Seventy-five percent of my class was kids just discussing science. It turns out that works really well, because kids love to argue about stuff."

The combination of Goodman's pedagogical approach and the fact that students were learning algebra and physics simultaneously made his course enormously popular. Soon, students in the school's other career and technical fields were asking administrators if they could take physics in the ninth grade—and by 2003 every freshman was taking the course. What's more, many of these students went on to take AP physics, with a remarkable pass rate.

By 2005, the school's students were taking and passing the AP physics exam at a rate that was 13 times the state average. The percentage of students from this voc-ed school taking AP physics was easily No. 1 in the state, more than double the next-highest school's percentage.

State leaders wanted to replicate this success throughout the state's high schools. Around the same time, the New Jersey Education Association wanted to prepare its members for the new teacher accountability measures coming down the pike. These factors led to the formation of the New Jersey Center for Teaching and Learning, a nonprofit research and development organization, and Goodman became its executive director.

"One of our goals is to get schools to stop teaching science backward," he said. "The only reason we teach biology, then chemistry, then physics is because of a decision made in the 1800s." But as Goodman proved, teaching physics while students are just learning algebra sets them up for success in all of the STEM disciplines, while making science and math more meaningful. And when students understand physics, they can explore other science topics at a level of sophistication that goes beyond simply memorizing facts.

The NJCTL also creates free and open instructional materials and trains teachers in student-centered instruction. Its training extends to schools in Africa and elsewhere, and the center also has trained 197 veteran educators to become physics teachers over the last seven years.

The approach that Goodman pioneered has led to higher participation in AP physics among minority students than the national average, helping to close the STEM achievement gap. What's more, Bergen County Technical High School is now ranked 28th in the nation and has had several students accepted into MIT. "Every single one of them was rejected by the math and science academy down the street," Goodman said.

He concluded: "I'm not saying that all of these students will become physicists. But we want every student to be able to become a doctor if they want to, for instance—and they can't do that if they never develop an interest in science." #