I began teaching at Bergen Tech in Teterboro in 1999.

I had left a successful business career to teach in high school.

I was hired to start a Pre-Engineering program.
I found:

• A classroom with only computer stations.

• Students who had not taken Algebra I.

• A sequence of instruction that didn’t make sense.
I solved these problems by

• “Borrowing” round tables from the faculty room

• Teaching Algebra I and Algebra-Based Physics together

• Changing the science sequence to physics-chemistry-biology
  • Sche
The Result for the Pre-Engineering Program

- Students loved the science and mathematics courses
- Student outcomes were very positive
- Students in other majors (culinary, fashion, automotive, etc.) petitioned the principal to be able to take the same courses
The Result for the School:

• Students loved science & mathematics.

• By 2003, all students were taking the same science and math courses…no tracking by ability.

• By 2005, the school was #1 in the state for taking AND passing Advanced Placement Physics B.
That school is rated among the top 31 high schools in the U.S., out of more than 14,000 high schools

- Newsweek: #28 & “Overcoming the Odds” Award
- US News and World Report: #31
- Niche Magazine: #10
By 2006:

- NJ State Teacher of the Year
- Doctoral Dissertation documented PSI and its results
- The New Jersey Department of Education & the New Jersey Education Association wanted to scale this up to benefit all students.
To scale to more schools we created:

• The Progressive Science Initiative (PSI)

• Progressive Mathematics Initiative (PMI)

• A major challenge to scaling: lack of physics and chemistry teachers
We needed many more physics and chemistry teachers.

Teaching is hard; science is easy.

Teacher Education

• We’d learned how to teach any student physics and chemistry.

• Why not teach physics and chemistry to teachers, to produce the needed new teachers of those subjects?

• There are many more teachers than physics majors.
Teacher Education

- #1 producer of physics teachers in the United States (220 in last eight years).
- Major producer of U.S. Chemistry teachers (48 in seven years).
- Racially and gender diverse STEM teachers who serve as role models for their students.
Teacher Education

Started producing physics & chemistry teachers in North Jersey in 2009-10.

Work continued in North Jersey and spread across the state.

#1 Producer of U.S. physics teachers every year since we started.
CTL is:

The #1 producer of physics teachers in the United States every year since 2009.

A major producer of chemistry teachers every year since 2010

The #1 producer of free editable course materials for the teaching and learning of science and mathematics.
Impact on AP Physics B Participation

2014

- Black: 6.92% (PSI), 0.80% (NJ), 0.64% (US)
- Hispanic: 8.47% (PSI), 1.35% (NJ), 1.14% (US)
- Female: 10.28% (PSI), 1.83% (NJ), 1.47% (US)
- Male: 11.94% (PSI), 3.21% (NJ), 2.61% (US)
- All Students: 11.11% (PSI), 2.54% (NJ), 2.06% (US)
Impact on AP Physics B Passing Rates

2014

- Black: 
  - PSI: 0.61%
  - NJ: 0.18%
  - US: 0.18%

- Hispanic: 
  - PSI: 1.96%
  - NJ: 0.50%
  - US: 0.39%

- Female: 
  - PSI: 3.12%
  - NJ: 1.11%
  - US: 0.76%

- Male: 
  - PSI: 5.20%
  - NJ: 2.27%
  - US: 1.66%

- All Students: 
  - PSI: 4.16%
  - NJ: 1.71%
  - US: 1.22%
The Gambia Pilot


Teacher training and technology integration implemented in 24 schools over three years.

Outcomes measured: teacher performance, student attitudes and student performance on international exams.
Challenges

1. Overcrowded classrooms, with children in rows
2. Pupils with gaps in their prior knowledge
3. Teachers who need more content knowledge
4. Intermittent electricity
5. Need for regular maintenance of equipment
As many students can be seated in groups as at benches.

These small groups become learning communities which drive collaboration rather than memorization.

Student polling devices then reconnect the small groups to the overall class.
2. Pupils with gaps in their prior knowledge

Social constructivism allows peers to address individual student weaknesses.

Teacher can draw from and adapt any K-12 materials to address class-wide gaps.
3. Teachers who need more content knowledge

Teachers learn the content from the same materials they will then use to teach it.

Teaching reinforces prior learning and continuously improves teacher content knowledge.

Teachers focus on teaching, not writing courses.
4. Intermittent Electricity

The PSI-PMI model was developed without any technology, so can function without it.

The value of technology, and the electricity it requires, is to speed the process of scaling.

Intermittent electricity only affects the use of projectors since student polling devices and laptop computers can function during gaps in electricity.
5. Need for regular maintenance of equipment

Moving to:

Laser-LED Hybrid “Lamp Free” Projectors

Tablets to replace printed copies or textbooks
I am interested in studying science in the future.

I feel comfortable learning from my mistakes in class.

Working with a group helped me learn.

I enjoy solving math and science problems with my friends.
“I like solving problems in class with the teacher and my friends.”
2015 WASSCE Results

600% increase in the number of PSI students scoring a “1” (the highest score) in physics.

300% increase in the number of PMI students scoring a “1” in further mathematics.

Performance significantly outpaced the control group.

Source: Hanover Research, February 2016
2015 WASSCE Results

500% increase in the number of PSI student scoring in the top three categories.

50% increase in the number of PMI students scoring in the top three categories.

Performance significantly outpaced the control group.

Source: Hanover Research February, 2016
The Gambia Project: Next Steps

English Language Arts courses for Grades 7-12 to complement mathematics and science scale-up

Scaling from 24 to 72 classrooms in the current 24 schools

Then, expanding to many more schools
Lesotho

Three Year Project

Began in January 2017

The Ministry of Education and Training

Teacher training and technology integration to be implemented in 24 schools
THE TRAINING I RECEIVED WAS SUFFICIENT TO TEACH PSI-PMI. My students will enjoy learning science and math using the PSI-PMI approach. My students will enjoy learning in social groups. My students will enjoy using student polling devices or other student polling practices. I am confident that I will be successful teaching PSI-PMI. PSI-PMI will lead to higher levels of student achievement.
Empowering Teachers …Leading Improvement

www.njctl.org
The Progressive Science Initiative (PSI) & Progressive Mathematics Initiative (PMI)

Provide a simple, scalable solution to improving the teaching and learning of science and mathematics.

Empower all teachers to effectively teach K-12 science and mathematics.

Provide access to quality instruction in science and mathematics to all students.
PSI-PMI: A Model for Teaching Science and Mathematics at the Secondary Level

I. What are its essential features?

II. Why does it work? (theoretical framework)

III. What does it require to work?

IV. What are its results
I. Essential Features of PSI-PMI

1. Coherent curricula.

2. Free editable course materials that are welcoming to **all** students and teachers.

3. A new student centered pedagogy.

4. Technology that integrates curriculum, pedagogy, assessment and teacher development.

5. Teacher training and support.
1. An example of coherent curricula:

- Vertical & Horizontal Alignment
- Strong Flow & Coherence

Diagram:

- 9th Grade: Algebra, Physics
- 10th Grade: Geometry, Chemistry
- 11th Grade: Trigonometry, Biology
2. Free, Editable Materials

For teaching almost all K-12 science and mathematics.

Eliminate the need for textbooks, creating lesson plans, writing tests and homework.

Save the expense of textbooks.

Lower the burden on teachers, so they can focus on teaching.

Include 100,000+ slides and 3500+ word documents.

www.njctl.org
Last Year

- 4,800,000 Pageviews
- 250,000 unique users
- In all 50 states and 180 countries.
- More than 100,000 slides and 3500 Word documents.

4.8 million page views in the last 12 months.
3. The New Pedagogy

Direct Instruction:

- Interactive Whiteboard presentation
- Minimal “Teacher Talk”
- Teacher as part of social group
3. The New Pedagogy

Social Constructivism:

• Group problem solving
• Round tables
• Heterogeneous setting
3. The New Pedagogy

**Student polling devices** connect direct instruction and social constructivism through real-time formative assessment.
Example of Formative Assessment

Find the sum: $0.3 + 0.47$
Example of Formative Assessment
4. Technology

• Technology makes teaching and learning from shared materials efficient.

• Course materials are editable and can be broadly shared.

• Teachers use interactive projectors to present materials to students.

• Built in formative assessment questions are linked to student polling devices.
5. Teacher Training and Support

Teachers are taught using the same materials they will use to teach their students.

Shared materials enable teacher collaboration for planning, reviewing and support.
II. Why Does the Model Work?

Improves teacher content knowledge and pedagogy.

Free materials allow teachers to focus on student learning instead of creating materials.

Editable nature of materials allow local adaptation.

Standardized level of rigor enables Professional Learning Communities and common curricula and assessment.
III. What Does the Model Need to Work?

Necessary - Teachers committed to learning content and making shifts in pedagogy.

Necessary – Initial training and ongoing support to teachers.

Necessary – inexpensive lab equipment to use in classrooms.

Preferred – Electricity; supporting technology and classroom furniture.
Recommended Technology
(in priority order)

1. Group seating for students (ideally round tables and chairs)

2. Computer for teacher

3. Student Polling Devices (e.g. Turning QT)

4. Interactive projector or board
STEM Education for All Students

Social Justice
All students gain access to STEM careers.

Global Competition
Each society realizes the potential of its citizens.
PSI-PMI Paradigm Shift

For what world are we preparing our students?

Not for Isolated work:
factual recall;
sitting quietly;
transcribing;
accepting
PSI-PMI Paradigm Shift

For what world are we preparing our students?

Rather, for collaborative work:
critical thinking;
problem solving;
talking;
debating;
questioning