Robert Goodman, Ed.D

Executive Director
NJ Center for Teaching and Learning

&

Teacher
Bergen County Technical HS – Teterboro, NJ

bob@njctl.org             www.njctl.org
New Jersey
Center for Teaching and Learning

A Not-for-Profit Company

Founded in 2007 by New Jersey Education Association (NJEA) with the mission of empowering teachers to lead school improvement.

An independent board with members from business, higher education, philanthropy and government.
Opening STEM Career Paths for ALL students is a critical need for:

**Social Justice:** Providing all students a fair chance.

**Global Competitiveness:** Realizing the potential of all children.

**National Security:** Critical jobs must be done by citizens.
An Important Need

The problem is difficult and self-perpetuating.

**Entry Barriers:** Courses have been designed for selection not education.

**Teacher Shortages:** Not enough teachers to teach all children.

**Self-perpetuating:** Few successful students results in too few teachers.
Meeting that Need

“Start by doing what is necessary, then what is possible, and suddenly you are doing the impossible.”

-----Francis of Assisi
Meeting that Need

The necessary: Solve the problem of STEM access for 16 students in one classroom in 1999.

The possible: Scaling that solution beyond one classroom in New Jersey beginning in 2009.

The seemingly impossible: Scaling that solution to other U.S. states and countries.
What was Necessary in 1999

Started public school teaching in 1999.

Launched a pre-engineering program at a New Jersey vocational-technical high school.

Taught sixteen 9th grade students to begin program.

Told my students had completed Algebra I in 8th grade.
The First Challenge

Only 3 of my 16 students had taken Algebra I, but they were scheduled for Geometry and Biology.

- They weren’t prepared for Geometry.
- Biology wouldn’t help with Algebra or Engineering.
The Solution

Used 2 hours of the vocational time I had with them to create an on-ramp to STEM:

- 40 minutes of Algebra I.
- 40 minutes of mathematically rigorous Algebra-Based Physics.
- 40 minutes of Engineering.
Why Algebra-Based Physics?

- Requirement for almost all STEM career paths, more than any other subject.

- The foundation for science; it makes science make sense.

- Provides a use for mathematics; motivating students.
The Second Challenge

- Textbooks to teach mathematically rigorous Algebra-Based Physics didn’t exist.

- In the U.S. mathematically rigorous Physics was taught with Trigonometry or Calculus.

- Books that used just Algebra, were not mathematically rigorous.
Wrote a book for mathematically rigorous Algebra-Based Physics.

Topics were chosen to prepare students for Chemistry & AP Physics B.

AP Physics was critical to recognize what these Vo-tech students had achieved.
The Third Challenge

The room did not have tables, chairs, a blackboard or whiteboard, just computer stations.
The Solution

Round tables; a lucky break!

- The faculty lounge had a few five foot diameter round tables.
- The cafeteria had chairs.
- The storage room had a blackboard on wheels.
Social Constructivism

- These students had not been very successful in science or mathematics.

- But, they liked talking to each other, and working on questions and problems together.

- This led to a pedagogy which was welcoming to all students.
Social Constructivism

- Brief direct instruction.
- Students building mental models by solving increasingly complex problems.
- Working together at round tables.
The Result

Pre-engineering students loved mathematics & science.

- Enjoyed problem-solving with their friends.
- Learned that mathematics is useful.
- Learned that science makes sense, it’s not memorization.
The Result

Students in the other majors petitioned to take Algebra-Based Physics in 9\textsuperscript{th} grade.

- By 2003, all students in the school were taking Physics in 9\textsuperscript{th} grade.
- No tracking, all students in the same course.
- Many went on to AP Physics B.
The Result

By 2005 - 13 times the New Jersey state rate of students were taking and passing AP Physics B.

- #1 in the state; double the #2 school.
- Became 2006 New Jersey State Teacher of the Year.
The Possible: Extending the Work

The New Jersey DOE wanted to build this on-ramp to STEM careers in more NJ schools.

The NJEA formed the NJ Center for Teaching and Learning (CTL) and asked me to join the board.

A major goal of CTL became to extend this work.
Another Challenge in 2007

Extending this work broadly required:

- Schools to stop teaching HS science backwards.
- Developing free OER science and mathematics course materials that could be shared and edited.
- Many more Physics teachers.
Stop Teaching Science Backwards

9th Grade  10th Grade  11th Grade  12th Grade

Biology  Chem  Physics

Algebra  Geom.  Algebra II & Trig  Precalc
Make Science Make Sense

9th Grade 10th Grade 11th Grade 12th Grade

Physics → Chem → Biology

Algebra → Geom. → Algebra II & Trig
New HS Science Sequence – with APs

9th Grade
- Physics
  - Algebra
  - Geom.

10th Grade
- Chem
  - AP Physics
  - Algebra II

11th Grade
- Biology
  - AP Chem
  - Pre Calculus

12th Grade
- AP Bio
  - AP Calc
The Solution for Course Materials

As a STOY, I was given an interactive whiteboard and student polling devices.

We captured our pedagogy and content in SMART Notebooks.

Posted those editable Notebooks on www.njctl.org for the free use of all.
Pedagogy

Direct Instruction

- Interactive White Board (IWB) presentation
- Student Response Formative Assessment
- Teacher as part of social group
Pedagogy

Social Constructivism

- Round Tables
- Group Problem Solving
- Heterogeneous Setting
Formative Assessment

Student polling devices connect direct instruction and social constructivism through the use of real-time formative assessment.
1 Find the sum:

0.3 + 0.47
Formative Assessment

1. Find the sum:

\[ 0.3 + 0.47 \]
The Key: Correct Answer is Hidden

- Students must defend their answers.
- Students focus on short direct instruction.
- Demonstrations and labs extend learning.
Neuroscience, Vygotsky and Video Games

People like to struggle, and then win.

- If there’s no struggle, it’s boring.
- If there’s no win, it’s frustrating.

Releases dopamine, resulting in pleasure and memory retention.
Structure of Classroom Learning

Each topic has direct instruction and about 6 formative assessment questions.

- Topics (with demonstrations) comprise units.
- Units (with labs) comprise courses.
- The sequence of courses comprise education.
Creating Physics Teachers

- **PSI** has shown that all students can learn Physics.
- **PSI** has shown that all teachers can learn Physics.
- **PSI** teaches Physics to skilled teachers.
- **PSI** provides teachers the tools to teach Physics.
- To get the best teachers to become the best Physics teachers:
  
  “Teaching is hard; science is easy”
Extending Beyond HS Science

Approach extended to K-12 mathematics & science.


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www.njctl.org

Announcements

Job Posting: Curriculum Writer: K-8 Science
May 20, 2014

CTL is seeking talented teachers to write curriculum for its K-8 science courses. Continue reading ➔

Trenton Central High Adopts PSI-PMI
May 12, 2014

Sometimes, when the challenges are sharpest, people rise to meet them with surprising clarity and powerful unity. That’s what has happened in Trenton, where leaders from the Trenton Education Association (TEA), the Superintendent, Trenton Central High and Dunn Middle Schools’ administrators, and the Trenton Board of Education, came together to bring the Progressive Science Initiative® (PSI®) and the Progressive Mathematics...
Free Editable K-12 Course Content

Created electronic files capturing our course content AND method of teaching, eliminating textbooks.

- 100,000+ slides.
- 3500+ word documents.
- Almost all of K-12 mathematics and science.
- Posted at www.njctl.org.
In the last 12 months:

- 3.3+ million pageviews.
- 1.6 million file downloads.
- 613,000 visits
- 257,000 unique visitors.
- More than 1600 videos posted; watched 68,400 times; 113,000+ minutes
- Used in all 50 states and 192 countries.
Expansion (on the ground)

- Developed in one NJ school: 1999.
- Extended to 25+ Argentina schools: 2010.
- Extended to 3 other U.S. states: 2011.
- Extended to 24 West Africa schools: 2012.
Teacher Training

- #1 producer of U.S. Physics teachers (175 in six years).

- Major producer of U.S. Chemistry teachers (35 in six years).

- Trained 1430 teachers in 218 schools in the effective use of our free editable course materials.
PSI Creates Physics Teachers
175 Teachers Complete Physics Program
Eight of the top 20 NJ schools for taking AP Physics B are PSI Schools.

Students in these PSI schools versus those in these non-PSI schools:

- Economically disadvantaged: 61% versus 9%.
- 71% Black/Hispanic 71% versus 11%.
- Mostly urban versus mostly suburban.
Expanding to The Gambia
The Gambia Project

A World Bank funded pilot project to implement PSI- PMI in The Gambia

Duration: Two-years.

Funding: $500,000.

Start Date: Fall 2012.
The Gambia Project

Implementation Plan:

Train 24 physics and 24 mathematics teachers to teach Physics and Algebra using PSI-PMI in grades 9 or 10.

Equip 24 schools with the needed PSI-PMI classroom technology: teacher laptops, SMART Boards and student polling devices.
The Gambia Project

Outcome Goals:

Measure the effect on student learning.

Measure the effect on student interest in mathematics and science.

Measure the effect on teacher confidence in teaching these subjects.
The Gambia Project

Rollout:

One cohort of twelve schools (including twelve mathematics and twelve science teachers) to be trained in Year 1. These schools would be located near the capital in regions 1 & 2.

Second cohort of twelve schools to be trained in Year 2. These schools would be located away from the capital in regions 3, 4, 5 and 6.
The Gambia Project: Teacher Training

Cohort 1 (2012 – 2014)

14 schools participated, rather than the planned 12. Similarly, that resulted in 14 mathematics and 14 science teachers participating.

Pre-tests showed very low content-knowledge of physics and only slightly better content knowledge of mathematics.
Cohort 1

Teachers met for intensive training 3x per year to learn content and teaching methods (about 30 days per year).

- Cohort 1 mathematics teachers learned Algebra I and then Geometry.
- Cohort 1 science teachers learned Algebra-Based Physics and then Advanced Physics.
The Gambia Project: Teacher Training

Cohort 1
Teacher Training:
PSI-PMI
Methods and Pedagogy
The Gambia Project: Teacher Training

Cohort 2 (2013 - 2014)

12 schools (12 science and 14 mathematics teachers) from regions 3, 4, 5, and 6.

Taught by Gambian teachers from Cohort 1 with CTL support. Allowed the more rapid scaling of teachers trained and schools participating.

- Mathematics teachers learned Algebra.
- Science teachers learned Algebra-Based Physics.
The Gambia Project: Equip Schools

2012 - 2013
Equipped 24 classrooms in 12 Region 1 schools

• 9 Senior Secondary Schools.
• 3 Upper Basic Schools.

2013-2014
Expanded to 12 more schools in Regions 2-6.
• 8 Senior Secondary Schools.
• 4 Upper Basic Schools.
The Gambia Project: Quantitative Results

Cohort 1 Upper Basic School Students.

Benchmark: Gambia Education Certificate Exam (GABECE).

PSI-PMI students outperformed their peers by 12.4 to 25.2 percentage points on the June 2013 GABECE.
The Gambia Project: Quantitative Results

Cohort 1 Senior Secondary School Students.

Benchmark: PSI-PMI Pre and Post Test Data.

Students displayed positive and significant learning growth - - 21 and 11.3 percentage associated with the PSI and PMI programs, respectively.
Student Surveys (n = 696)

- I am interested in studying science in the future: 81% Strongly Agree, 7% Agree, 9% Neutral, 9% Disagree, 5% Strongly Disagree
- I feel comfortable learning from my mistakes in class: 83% Strongly Agree, 9% Agree, 9% Neutral, 9% Disagree, 5% Strongly Disagree
- Working with a group helped me learn: 85% Strongly Agree, 9% Agree, 9% Neutral, 9% Disagree, 5% Strongly Disagree
- I enjoy solving math and science problems with my friends: 92% Strongly Agree, 5% Agree, 9% Neutral, 9% Disagree, 5% Strongly Disagree
What did you like most about PSI-PMI?

What I like the most about PSI is that the class is always interesting and lively, it is never boring.

Solving science problems with friends and feeling more relaxed knowing that I could retake a test.

This project encourages group works and discussing with friends in class regarding to the topic you are treating.
Student Surveys

“I like solving problems in class with the teacher and my friends.”
Teacher Surveys

The training I received was sufficient to implement PSI-PMI.

PSI-PMI will lead to higher levels of student achievement.

My students enjoy learning in social groups.

- Strongly Agree
- Agree
- Neutral
- Disagree
- Strongly Disagree
Teacher Surveys

What do you like most about PSI-PMI?

PSI-PMI provide a much deeper understanding of the concepts, and the program allows students to actively engage in class. Kids are fascinated by the technology and more engaged.

The program is very student-focused – the students are very engaged.
Teacher Surveys (cont’d)

What do you like most about PSI-PMI?

*It minimizes time wasting, encourages collaboration and participation of the students.*

*Students learn more from each other. I get a quick feedback. I have more time to monitor students while they are working.*
The Gambia Project: Next Steps

Expansion of PSI and PMI to all 147 Upper Basic and Senior Secondary Schools

$11M of funding to be provided by Islamic Development Bank

Pending clearance of current IDB open projects with The Gambia

Three year project should begin in early 2016
The Gambia Project: Next Steps

$1.3M contract with Ministry of Basic and Secondary Education, funded by World Bank, for additional digital course content

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

Secondarily, to complete all mathematics and science topics in West Africa standards
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
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Empowering Teachers …Leading Change
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