# Teacher Professional Development Programs in Grades 3-8:

## Promoting Teachers' and Students' Content Knowledge in Science and Engineering

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# Overview

- The USED NJ MSP program, PISA, provided the foundation for the development of the NSF PISA$^2$ program.
- This presentation will discuss the findings of the PISA program in Year 3 and describe its PD components.
- PISA$^2$ aims to increase the academic achievement & 21$^{st}$ century skills of elementary & middle school students in science & engineering.

| Key Features | | PISA[2] |
|---|---|---|
| Funding Agency | USED MSP | NSF MSP |
| Funding Years | 2007-2010 | 2010-2015 |
| Participants | 46 teachers<br>~800 Grade 3-5 students (treatment) | ~100 teachers per cohort x 4 cohorts<br>~6,000 Grade 3-8 students in Year 1 (treatment) |
| Partner Schools | 21 schools in | 40 schools in NJ |
| Research Studies | Quasi-experimental | Quasi-experimental |
| Components of the PD program | ▪ 80-hour summer institute<br>▪ three PD days (school year)<br>▪ monthly classroom support visits<br>▪ 124 hours total PD hours | ▪ 15-credit hours of graduate coursework<br>▪ two PD days (school year)<br>▪ monthly classroom support visits<br>▪ ~270 hours over 2 years |
| Goals | ▪ improve teachers' content knowledge & pedagogical content knowledge in science & engineering<br>▪ improve students' content knowledge in science and & engineering<br>▪ develop students' 21st century skills | ▪ improve teachers' content knowledge & pedagogical content knowledge in science & engineering<br>▪ foster improved teacher attitudes & beliefs towards teaching science & engineering<br>▪ improve students' content knowledge in science and & engineering<br>▪ develop students' 21st century skills<br>▪ foster students' positive attitudes & beliefs towards science & engineering subjects/careers<br>▪ Build district capacity for science education leadership & strategic planning (ECC Trilogy)<br>▪ promote institutionalization & sustainability |

# PISA Partnership & Roles

- Stevens Institute of Technology
- Montclair State University
- Liberty Science Center
- Institute for Learning Technologies; Teachers College, Columbia University
- 5 large urban school districts
- 4 non-public schools
- 46 Grade 3-5 teachers
- 796 students of MSP teachers

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# PISA Goals

- Improve teachers' content knowledge in science & engineering
- Improve teachers' pedagogical knowledge in creating & adapting science inquiry & engineering lessons
- Improve students' content knowledge in science & engineering (Grades 3-5)

**Year 1: 2007-08**
Life & Environmental Science

**Year 2: 2008-09**
Earth & Space Science

**Year 3: 2009-10**
Physical Science & Math

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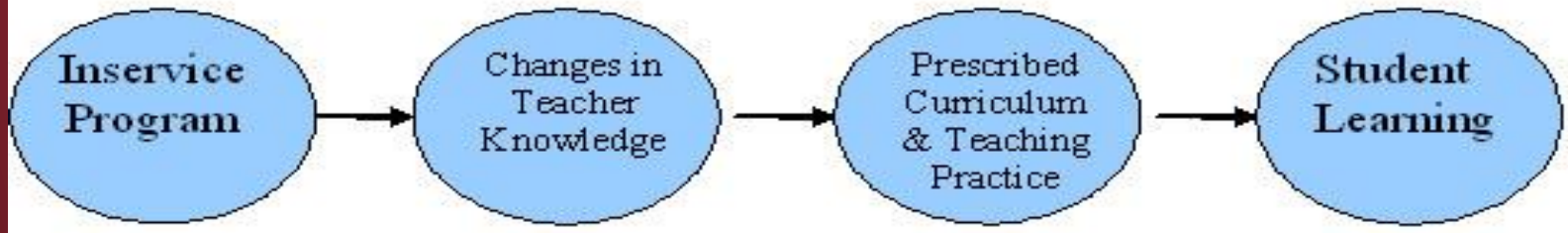
# Components of the PD

- Two-week summer institute
  - Science lessons with focus on scientific inquiry
  - Engineering curricula
  - Real-time data, telecollaborative projects
  - Faculty-led workshops, lab tours, & hands-on activities

- 3 PD workshops during school year (f2f & online)
- Monthly classroom visits
- Total: 124 hrs PD for each participant/year x 3 years

# Background

- PD improves teachers' knowledge, beliefs about teaching, & classroom enactment (Fishman, Marx, Best, & Tal, 2003)
- Teacher PD in math does have significant positive effects on student achievement (Blank & de las Alas, 2009)
- Two-week PD improved teachers' confidence in their knowledge & in teaching engineering principles (Hynes & dos Santos, 2007)



# Lessons & Activities

# Evaluations

**Teachers**

- Pre- and post- tests in
- treatment and comparison groups
- Questions taken from TIMSS, MOSART, NJASK & MOS (20 science & related math, 5 engineering)
- Classroom implementation survey

**Students**

- Pre- and post- tests for treatment and comparison groups
- Questions taken from TIMSS, MOSART, NJASK & MOS (14 science & related math, 5 engineering)

# Year 3 Results- Teachers

Treatment Teachers:

- 17% increase
- statistically significant
- (t(45)= -3.453, p<.01)

| **Treatment Group** | Mean (n=46) |
|---|---|
| Teacher Score Pre-test | 14.09 |
| Teacher Score Post-test | 16.52 |

Comparison Teachers:

- 7% increase
- Not statistically significant
- (t(37)= -1.386, p>.05)

| **Comparison Group** | Mean (n=38) |
|---|---|
| Teacher Score Pre-test | 12.55 |
| Teacher Score Post-test | 13.42 |

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# Year 3 Results - Students

Treatment Students:

- 46% increase
- statistically significant
- ( t(637)= -23.543, p<.01)

| Treatment Group | Mean (n=638) |
|---|---|
| Raw Score (pre) | 6.68 |
| Raw Score (post) | 9.77 |

Comparison Students:

- 17% increase
- statistically significant
- ( t(540)= -10.346, p<.01)

| Comparison | Mean (n=541) |
|---|---|
| Raw Score (pre) | 7.16 |
| Raw Score (post) | 8.39 |

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# Year 3 Findings

- Teachers' post-test scores were a significant predictor of students' post-test scores
- The more program activities a teacher performed, the higher the students' post test scores

- The number of engineering activities that the students were exposed to in the classroom was a significant predictor of their science post-test scores.

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# Engineering & Students' 21st Century Skills

*"The engineering design lessons are the ones that [stand out]. I think the fact that they are able to problem solve (even as a group, which is a feat for students) and create/build something drives home the lesson."* (Problem Solving & Collaboration)

*"…they would fully understand that you can try again to improve your designs. They need to know that there is a correct solution; however it shows them that it is possible to have several other solutions."* (Creativity & Innovation)

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# Development of PISA$^2$

- To enhance teachers' content knowledge in science & engineering (S&E) and cultivate positive attitudes & beliefs towards teaching S&E
- To increase students' content knowledge and experiences in S&E
- To promote students' 21st century skills
- To institutionalize new graduate programs in STEM education and impact undergraduate teaching & learning
- To increase the number of teachers with elementary endorsement in science
- To build leadership and capacity in partner school districts

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# Components of PISA$^2$

- 400 NJ Teachers in Grades 3-8, 120 School Administrators, Stevens' Students & Faculty
- Five new courses
  - Fundamental Principles of Physical Science
  - Fundamental Principles of Earth Science
  - Energy Production & Consumption
  - Understanding Global Change
  - Engineering Solutions to the Challenges of Energy & Global Change

- Two PD workshops each year
- Monthly classroom support visits
- Leadership & Capacity Building for Science Education Reform

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# Challenges

- Accelerated start-up led to time constraints in course development, recruitment.
- Different pedagogical approaches, teaching philosophy, and expectations among STEM faculty.
- Uneven mathematics and computer technology preparation of teachers grades 3-8.
- Varying science curricula, pacing charts, pedagogical focus of participating 12 districts

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# Questions?

www.stevens.edu/ciese/pisa2