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 & 21st century skills of elementary & middle school students in science & engineering.
<table>
<thead>
<tr>
<th>Key Features</th>
<th>PISA²</th>
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<tbody>
<tr>
<td>Funding Agency</td>
<td>USED MSP</td>
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<tr>
<td>Funding Years</td>
<td>2007-2010</td>
</tr>
<tr>
<td>Participants</td>
<td>46 teachers</td>
</tr>
<tr>
<td></td>
<td>~800 Grade 3-5 students (treatment)</td>
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<td>Partner Schools</td>
<td>21 schools in</td>
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<tr>
<td>Research Studies</td>
<td>Quasi-experimental</td>
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<tr>
<td>Components of the PD program</td>
<td>• 80-hour summer institute</td>
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<td>• three PD days (school year)</td>
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<td>• monthly classroom support visits</td>
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<td></td>
<td>• 124 hours total PD hours</td>
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<tr>
<td>Goals</td>
<td>• improve teachers’ content knowledge &amp; pedagogical content knowledge in science &amp; engineering</td>
</tr>
<tr>
<td></td>
<td>• improve students’ content knowledge in science and engineering</td>
</tr>
<tr>
<td></td>
<td>• develop students’ 21st century skills</td>
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<td></td>
<td>• foster students’ 21st century skills</td>
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<td></td>
<td>• foster students’ positive attitudes &amp; beliefs towards science &amp; engineering subjects/careers</td>
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<td></td>
<td>• Build district capacity for science education leadership &amp; strategic planning (ECC Trilogy)</td>
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<td>• promote institutionalization &amp; sustainability</td>
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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
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
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
- \( (t(45) = -3.453, p < .01) \)

### Comparison Teachers:
- 7% increase
- Not statistically significant
- \( (t(37) = -1.386, p > .05) \)

<table>
<thead>
<tr>
<th></th>
<th>Mean (n=46)</th>
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<tbody>
<tr>
<td>Treatment Group</td>
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<tr>
<td>Teacher Score Pre-test</td>
<td>14.09</td>
</tr>
<tr>
<td>Teacher Score Post-test</td>
<td>16.52</td>
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<table>
<thead>
<tr>
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<th>Mean (n=38)</th>
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<tbody>
<tr>
<td>Comparison Group</td>
<td></td>
</tr>
<tr>
<td>Teacher Score Pre-test</td>
<td>12.55</td>
</tr>
<tr>
<td>Teacher Score Post-test</td>
<td>13.42</td>
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Year 3 Results - Students

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

<table>
<thead>
<tr>
<th>Treatment Group</th>
<th>Mean (n=638)</th>
</tr>
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<tbody>
<tr>
<td>Raw Score (pre)</td>
<td>6.68</td>
</tr>
<tr>
<td>Raw Score (post)</td>
<td>9.77</td>
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</tbody>
</table>

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

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<thead>
<tr>
<th>Comparison</th>
<th>Mean (n=541)</th>
</tr>
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<tbody>
<tr>
<td>Raw Score (pre)</td>
<td>7.16</td>
</tr>
<tr>
<td>Raw Score (post)</td>
<td>8.39</td>
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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.
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)
Development of PISA²

- 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
Components of PISA²

- 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
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.
Questions?

www.stevens.edu/ciese/pisa2