

Teacher Professional Development in Grades 3-5: Fostering Teachers' & Students' Content Knowledge in Science & Engineering

**Augusto Z. Macalalag Jr.
Mercedes McKay**

Center for Innovation in Engineering & Science Education

NJ Math-Science Partnership



- Stevens Institute of Technology
Montclair State University
Liberty Science Center
- 43 Grade 3-5 teachers in
18 public & 3 non-public urban
schools in Northern New Jersey
- 737 students of MSP teachers
- Reporting on the 2nd year of the
3 year project

Research Questions

- Does the PD enhance teachers' content knowledge in targeted science & engineering topics?
- Does the PD result in improved classroom practice, defined as implementation of science inquiry & EDP?
- Will the treatment group students improve their content knowledge?



Year 1: 2007-08

Life &
Environmental Science

Year 2: 2008-09

Earth & Space Science

Year 3: 2009-10

Physical Science & Math

Needs

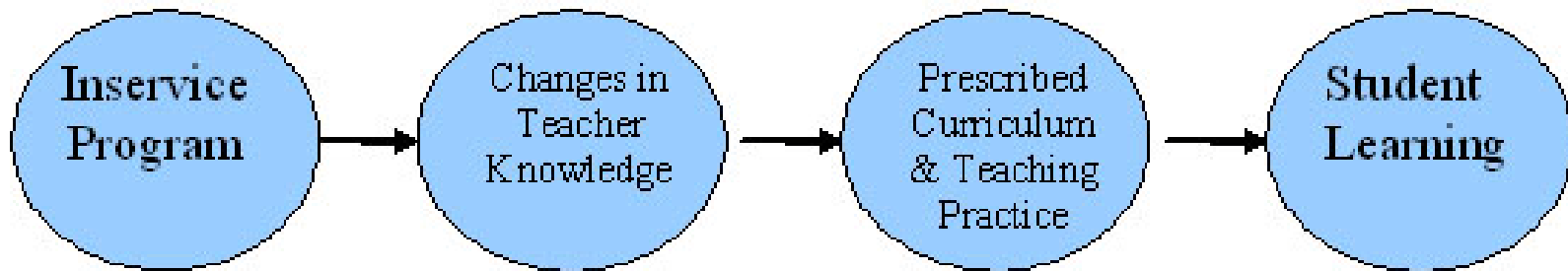
- To increase STEM, specifically engineering, in K-12 education (Committee on K-12 Engineering Education, 2009)
- Scientific & technological literacy are crucial for students to compete in the 21st century (National Center on Education and the Economy, 2006)
- Most teachers teaching engineering as part of the K-12 curriculum lack the knowledge about what engineering is and how they might teach the subject (Cunningham, et.al, 2007)

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)

Teacher Professional Development Model

Kennedy (1998)



Program Structure

- 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 (f2f & online)
- Monthly classroom visits
- Project website and listserv



Year 2



Designing & Testing
Windmills



Local Geology “Rock Walk”



Designing a Wall

Participants

Treatment Group

- Teachers: 43
- Students: 737
- Classes: 37

Comparison Group

- Teachers: 35
- Students: 684
- Classes: 35

Teacher Evaluation

- Pre/post tests in treatment and comparison groups
 - Questions taken from TIMSS, MOSART, NJASK & MOS (20 science, 5 engineering)
- Teacher Implementation Survey
 - End of the school year (treatment teachers only)



Student Evaluation

- Pre/post tests in treatment and comparison groups
 - Questions taken from TIMSS, MOSART, NJASK & MOS (18 science, 5 engineering)

Year 2 Results- Teachers' Knowledge in Science & Engineering

- Two groups had the same baseline knowledge
- The treatment group's mean score increased by about 13% (pre/post tests) while the comparison group's mean score increased by only 3%.
- Treatment teachers' post-test scores improved significantly even when their slightly higher pre-test scores were taken into account.

Year 2 Results- Students' Knowledge in Science & Engineering

- Students of treatment teachers: mean score increased by about 27%, compared to an increase of only 16% for the comparison group.
- Students of treatment teachers: had higher post test scores in science than the comparison group.
- Students of treatment teachers: post test scores in engineering improved significantly compared to the comparison students.

Year 2 Results (Survey)- EDP Promotes Students' 21st Century Skills

“The EDP is a great process to incorporate in the classroom. The students begin to apply the process in their learning, not just for the projects. They accept and use the idea of testing and trying again, never giving up.” (Problem Solving)

Year 2 Results (Survey)- EDP Promotes 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)

Year 2 Results (Survey)- EDP Promotes Students' 21st Century Skills

“...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)

Year 2 Results- Implementation of Activities & Students' Test Scores

- Students' content knowledge in science and engineering increased with:
 - The number of implemented activities implemented by teachers
 - Teachers' content knowledge
 - Exposure to twelve or more science and engineering activities

Conclusion

- Treatment teachers & students significantly improved their content knowledge in science & engineering after one year of PD program.
- Teachers mentioned that EDP promoted 21st century skills (problem solving, collaboration, creativity, & innovation) of their students.
- Engineering lessons contribute to students' knowledge in science.
- Teachers' content knowledge is a predictor of students' knowledge.

For More Information



PISA
Partnership to Improve Student Achievement

- Home
- Teachers
- Workshops
- Resources
- Listserv
- Learning Modules
- Highlights
- Contacts

Overview

A partnership of 68 teachers from 24 schools from the districts of Bayonne, Hoboken, Jersey City, Newark, Piscataway, Weehawken, and two non-public schools, together with Stevens Institute of Technology, Montclair State University, and Liberty Science Center, will provide teams of teachers with deeper science content knowledge, research-based professional development, and experience with innovative science and engineering curricula and materials for Grades 3-5. The Boston Museum of Science's National Center for Technological Literacy and Bank Street College of Education are also partners in this collaboration. Teachers will participate in a dynamic and supportive learning community designed to address topics in key content areas in Grades 3-5 science, engineering, and technology education. Year 1 activities will focus on New Jersey Core Curriculum Content Standards 5.5 and 5.10 (life and environmental sciences) and 8.2 (technology education).

An intensive, two-week summer institute will involve teachers in collaborative learning through engagement in science inquiry, engineering design, foundational learning in core science topics, and the development of a Science Technology Engineering Mathematics Learning Module (STEM Learning Module) that introduces topics in science through inquiry-based activities and use of the engineering design process. Teams will work together on developing the module, including identification of student science learning objectives (tied to the district science curriculum and the NJCCCS), lesson plans, implementation and classroom management plans, and student assessments.

Three professional development days during the school year and monthly classroom visits will support teachers as they implement content and materials during the school year.

Assessment of student and teacher learning will take place, within participating classrooms and in comparison classrooms.



STEVENS
Institute of Technology



State of New Jersey
DEPARTMENT OF EDUCATION

www.stevens.edu/ciese/pisa