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

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- Stevens Institute of Technology
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- 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
Designing a Wall

Local Geology
“Rock Walk”
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)
“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)
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

www.stevens.edu/ciese/pisa