Instructional Materials to Support the Next Generation Science Standards:

Results of a Proof-of-Concept Study

Eric R. Banilower
Michele M. Nelson
Peggy J. Trygstad

Horizon Research, Inc.

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Changes and Challenges for Elementary Science

- Next Generation Science Standards (NGSS) calls for integration of
  - Disciplinary Core Ideas (e.g., forces and motion)
  - Practices (e.g., modeling)
  - Crosscutting concepts (e.g., patterns)
- Time, content knowledge, and comfort level

What is Known about Effective Science Instruction?

- Effective science instruction includes:
  - Elicitation
  - Engagement
  - Use of evidence
  - Sense-making

Science Instruction & NGSS: Implications for Teaching

- Elementary teachers will need:
  - Curricula consistent with NGSS
  - Teaching methods consistent with Effective Science Instruction
  - Support!

Study Hypothesis

- Improvements can be fostered by curriculum materials that:
  - Are aligned with NGSS learning goals
  - Are designed to embody principles and practices of effective science instruction
  - Feature educative supports--embedded PCK

Research Questions

1. What is the impact of the unit on students' conceptual understanding of important ideas in force and motion, overall, and for student subgroups (e.g., race/ethnicity, gender)?

2. To what extent does teacher content knowledge mediate the development of students' conceptual understanding?

3. To what extent does implementation fidelity of the unit affect the development of students' conceptual understanding?

Description of the Intervention

Participants

- Participants recruited from three similar school districts in a single state
- Treatment and comparison groups based on convenience
- Treatment group provided with a set of learning-theory aligned instructional materials, implementation guide, and week of PD

Curriculum Materials

- Covered force and motion topics
- Developed and structured according to research on how people learn
- Uses findings from physics education research (canonical PCK)

Structure of a Typical Student Activity

- "What do we think" – surfaces prior knowledge
- Activities – engages learners with phenomena that provide evidence for the target idea
- "How do you know" – encourages the use of evidence from the activity to support a claim
- "Making Sense" – helps learners relate the target idea to their initial thinking, what they did in the activity, and apply the idea to other contexts/examples.

Implementation Guide

- Introduction to each lesson
  - Targeted ideas
  - Common misconceptions
  - Suggestions for focusing students on relevant aspects of the activity
  - Materials needed

- Additional guidance embedded in the activity
  - Logistical suggestions
  - Implementation tips
  - Expected student responses to questions and what those answers indicate about student thinking

Professional Development

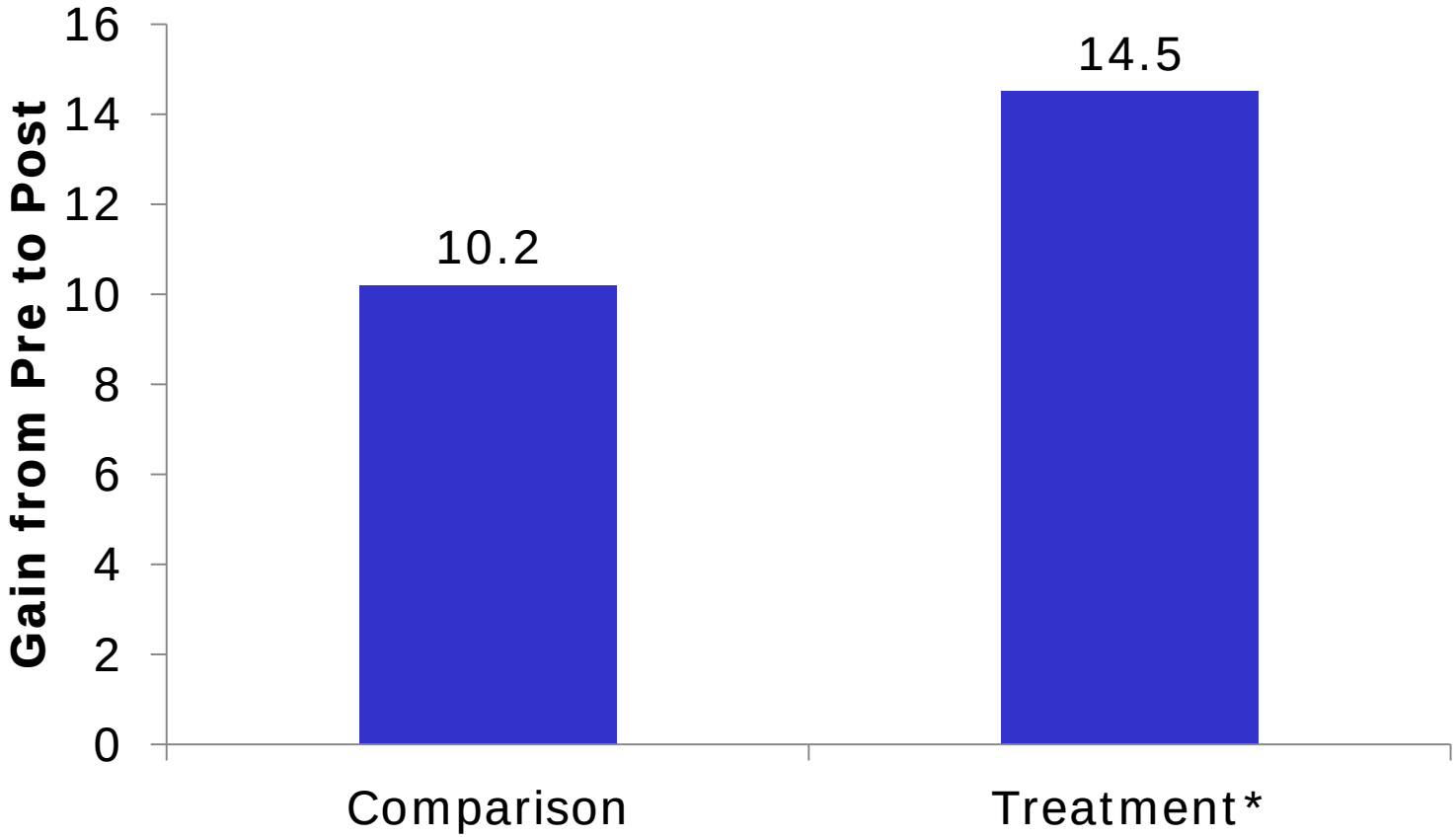
- Deepen teachers' content knowledge
- Foster teachers' understanding of a learning-theory aligned approach to teaching
- Engage teachers with content in a way they could take back and apply to classrooms

Data Collection

1. Teacher content assessments
2. Student content assessments
3. Teacher questionnaires – instructional practices, beliefs about science instruction, contextual factors
4. Classroom observations – focusing on student opportunity to learn and fidelity to the materials

Results

Student Assessment Data



* Students of treatment teachers had significantly greater gains than students of comparison teachers, $p < 0.05$.

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- No evidence that teacher content knowledge played a role in the effect of the treatment on student achievement

- Students of teachers classified as high fidelity implementers had greater achievement gains than students of medium fidelity implementers

Implications

- Embedding canonical PCK into instructional materials appears to be an effective approach for increasing student understanding in science.
- Instructional materials appear to be more effective when implemented with high fidelity
- Approach represents a way to facilitate successful implementation of the NGSS that is both cost effective and scalable

Questions?

www.horizon-research.com/aim

aim@horizon-research.com

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