Science IDEAS: Integrating Reading/Language Arts within Science Instruction Across Grades K-5

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*Presentation at the Literacy for Science in the Common Core ELA Standards and the Next Generation Science Standards Workshop, Washington, DC.*

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Presentation Overview

• Overview: Science IDEAS Model (Grades 3-5)
  – Integration of literacy within science instruction
  – Increased time for science instruction by replacing reading/language arts (except literature)
  – Multi-year research findings: Achievement effects - Science and Reading

• Interdisciplinary Perspectives that Support Model (Why the Model Works)

• Implications for Linking CCSS and NGSS

• Addressing CCSS at the Elementary and Secondary Levels

• Science IDEAS Model for Linking CCSS and NGSS

• Conclusions/Questions
Science IDEAS Model: Grades 3-5

Science

IDEAS

Meaningful Learning in Science
With Reading Comprehension and Writing
Science IDEAS Model: Grades 3-5

ENHANCED CURRICULUM CONCEPT MAP FOR FACTORS THAT EFFECT WATER EVAPORATION

Activity 12- Reflection
Activity 13- Add. Reading
Activity 7- Reading
Activity 2- Real Examples
Activity 11 Prob. Solv.
Activity 8- Concept Map
Activity 9- Writing
Activity 6- Journaling
Activity 10- Application
Activity 3- Demonstration
Activity 4- Hands-on Act.

Water Evaporation

Morning Dew Disappearing, . . . .
Damp Cloth Drying, . . . .
Heated Water Disappearing From a Pot, . . . .
Wet Sidewalk Drying

Faster or Slower Rate

Combined Effects of 3 Different Factors

Activity 1- Prior Knowledge
Phase of Matter Change Process
Liquid Changing to a Gas

Water as the Liquid
Water Vapor as the Gas

Enables

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Science IDEAS Model: Grades 3-5

• General Student Classroom Experience
  – Always learning more about what they are learning
  – Using what they have learned as prior knowledge for subsequent learning

• Specific Student Classroom Experiences
  – Multiple hands-on/inquiry activities directly linked to reading across multiple science sources focused on the same set of concepts
  – Continuous journaling opportunities to write about, reflect on and explain how evidence gathered during inquiry activities links to the concepts being learned
  – Use of propositional concept maps to organize and represent knowledge learned
Science IDEAS: Multi-Year Research Findings

Early Years: 199 - 2001

Science Achievement Differences (in Years)

- Year 4
- Year 3
- Year 2
- Year 1

Science Achievement Effects (E vs. C) in GE Years

Note: Year 1 students = grade 4; average/above average
Year 2 students = grade 4; average/above average
Year 3 students = grades 4.5; at-risk
Year 4 students = grades 4.5; average/above average/at-risk

Reading Achievement Differences (in Months)

- Year 4
- Year 3
- Year 2
- Year 1

Reading Achievement Effects (E vs. C) in GE Months

Note: Year 1 students = grade 4; average/above average
Year 2 students = grade 4; average/above average
Year 3 students = grades 4.5; at-risk
Year 4 students = grades 4.5; average/above average/at-risk
Science IDEAS: Multi-Year Research Findings

Recent Longitudinal Study: 2002-2007

Science GE Achievement
Effects (E vs. C): Grades 3-8

Reading GE Achievement
Effects (E vs. C): Grades 3-8
Recent Longitudinal Study (Replication): 2003-2008

Direct ———> Transfer

Science GE Achievement Effects (E vs. C): Grades 3-7

ITBS GE SCIENCE

GRADE

Science IDEAS: Multi-Year Research Findings

Reading GE Achievement Effects (E vs. C): Grades 3-7

ITBS GE READING

GRADE
Science IDEAS: Multi-Year Research Findings

• Four early studies teacher/classroom oriented (1992-2001)
  – Adj. GE (E vs. C) effects on MAT Science: (Range: +.93 GE to +2.3 GE)
  – Adj. GE (E vs. C) effects on ITBS Reading: (Range: +.33 GE to +.51 GE)

• Recent Longitudinal Studies
  – Schoolwide implementations: Grades 3-5 (N=12 schools)
  – Assessment of direct (grades 3-5) and transfer effects (grades 6-8)
    • 2002-2007: Adj. GE (E vs. C) effects: Grades 3-8
      – ITBS Science (+.38 GE)
      – ITBS Reading (+.32 GE)
    • 2003-2008: (Replication): Adj. GE (E vs. C) effects: Grades 3-7
      – ITBS Science (+1.03 GE)
      – ITBS Reading (+.53 GE)

• Adaptations to K-2 (E vs. C) effects (Grade 1-2 tested)
  • 8-week study: ITBS Science (+.42 GE). ITBS Reading (Grade 2) (+.72 GE)
  • 1 year study: ITBS Science (+.16 GE). ITBS Reading (+.58 GE)
Interdisciplinary Perspectives in Support of the Model

• Concept of Expertise and How Experts Operate (Bransford et al.)
  – Well-organized conceptual knowledge
  – Knowledge accessed and applied with automaticity

• Strong vs. Weak Problem Solving/Application (Anderson)
  – Transformation of declarative to procedural knowledge
  – Distinction between actions that are knowledge-based and those that are not

• Knowledge-Based Instruction/Intelligent Tutoring Systems (Brown et al.)
  – Structure of disciplinary knowledge provides framework for all instructional events
  – Insures instructional events are related in coherent fashion

• Reading Comprehension Addressed as a Subset of Meaningful Learning (Vitale & Romance)
Implications for Linking CCSS and NGSS

• CCSS and Content-Area Learning (as NGSS-focused instruction)
  – Raising the Question of CCSS and NGSS Directionality
    • Cognitive science research evidence argues that knowledge serves as the basis for advanced applications and meaningful learning
    • Rich content knowledge must be developed cumulatively within and across grades
    • Arguably, rich content knowledge provides a foundation necessary for the development of student proficiency with CCSS standards
  – CCSS recognize the importance of building in-depth student content knowledge (but)…the emphasis of CCSS standards are on general literacy not on meaningful content learning
    • CCSS are suggestive that teaching each standard will in some way further meaningful content learning
    • CCSS standards don’t incorporate the importance of cumulative meaningful learning as a basis for student literacy development
• Role of science in developing CCSS performance is logically the same at the elementary and secondary levels
  – Instruction at all levels should focus on in-depth understanding of core disciplinary concepts and concept relationships (e.g., NGSS)
  – Resulting disciplinary knowledge (NGSS) should be used as a foundation for CCSS literacy standards (e.g., reading, listening, writing, speaking)
Science IDEAS Model: Linking CCSS and NGSS

• Meets the requirement of developing in-depth science knowledge (NGSS) as a foundation for CCSS
  – Addresses conceptual science understanding in focused fashion
    • Hierarchically organized concepts and illustrative examples (for referential meaning)
    • Concept to concept relationships (for IF/THEN predictions)
    • Explanations of why phenomena occur (as abductive reasoning)
  – Incorporates argumentation and critical evaluation using science knowledge
• Includes science concept-based instruction in which propositional concept mapping provides an organizational framework for reading, listening, writing, and communication
• Is feasible to implement in K-5 settings
• Provides an evidence-based argument for increasing instructional time allocated to science instruction in which CCSS literacy could be integrated
• The grade 3-5 model is extensible to secondary content-area instruction
  – Advanced ideas instructional components provide transition from grade 5 Science IDEAS to grade 6 middle schools science instruction
  – Science IDEAS-based model for secondary content-area instruction consists of teacher planning and student-focused strategies
    • Teacher planning (e.g., focusing on core concept relationships, building propositional concept maps as instructional guides)
    • Student-focused (e.g., knowledge-focused reading comprehension strategy, student involvement in propositional concept mapping, use of instructional design strategies to accelerate student learning and assess mastery)
Conclusions and Questions

• Interpretation- NGSS science standards provide a content-based foundation for successful CCSS implementation across grades K-12

• Interpretation is supported by consensus research findings from cognitive science and related disciplines
  – Expert practices and development (expertise)
  – Knowledge-based problem solving
  – Knowledge-based instruction
  – Reading comprehension as a subset of meaningful learning

• Science IDEAS is an instructional model whose architecture could provide a sound foundation for CCSS standards in grades K-5 in a manner that would facilitate transfer to CCSS standards at the secondary level.
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