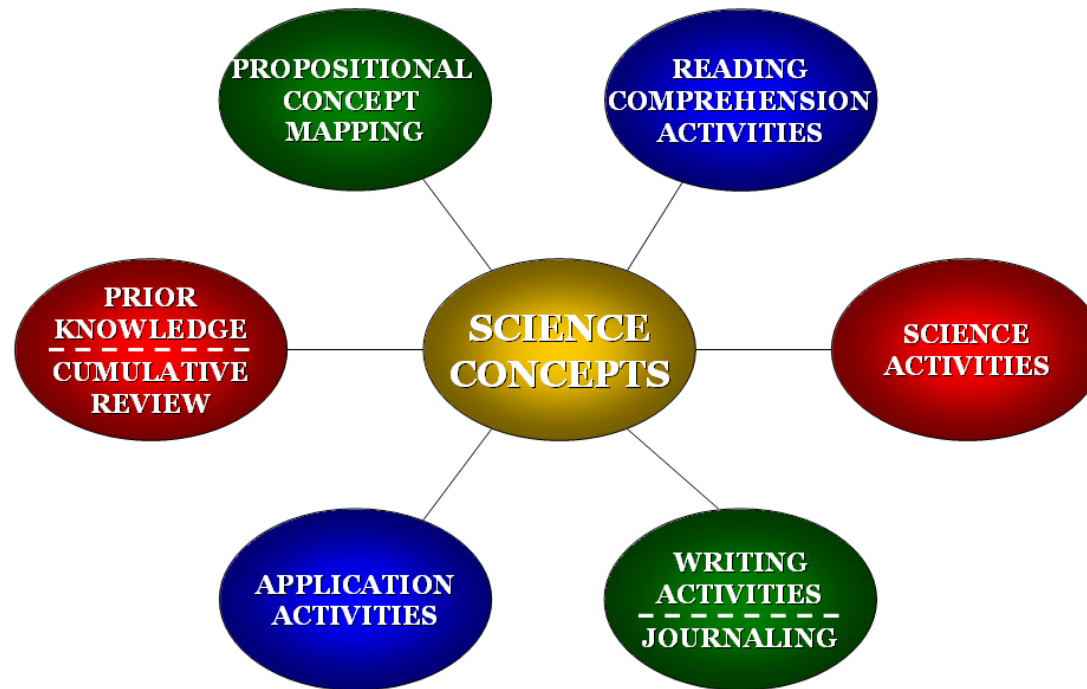


Science



IDEAS



Meaningful Learning in Science with Reading Comprehension and Writing



Michael Vitale (Co-PI)
East Carolina University
vitalem@ecu.edu

Nancy Romance (PI)
Florida Atlantic University
romance@fau.edu

Jerome Haky (Co-PI)
Florida Atlantic University
hakyj@fau.edu

Science IDEAS

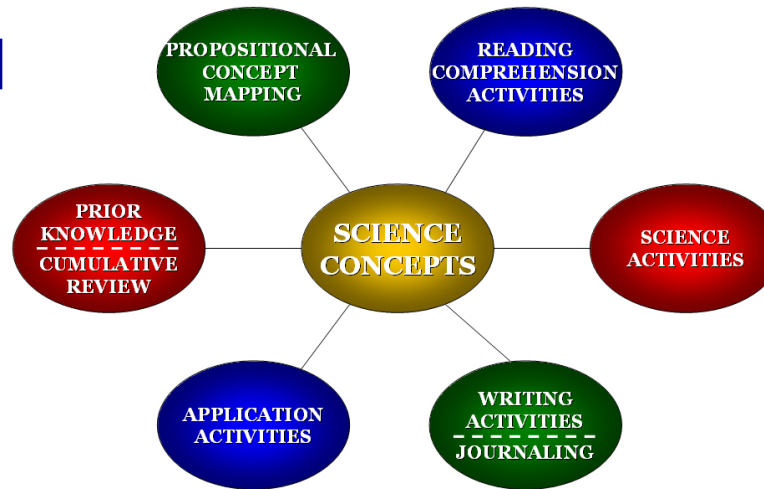
What is the Science IDEAS Project?

- Multi-year research and development project (2002-2009) funded by the National Science Foundation
- Designed to develop the capacity of schools to initiate and sustain the Science IDEAS model across grades K-5 (i.e., scale-up)
- Involved extensive teacher professional development and follow-up support, including the establishment of a teacher leadership cadre
- Established an organizational infrastructure for Science IDEAS implementation by schools
- Demonstrated the achievement effects of Science IDEAS at the K-5 level along with transfer effects at the middle school level in science and reading
- Created strategies and tools for use by schools in future scale-up of the Science IDEAS model

What is the Science IDEAS Instructional Model?

- Integrates reading comprehension within in-depth science instruction that cumulatively builds meaningful understanding in science by students
- Approaches reading comprehension as a form of meaningful understanding (in-depth learning) in science
- Implemented on a schoolwide basis in grades 3-5 through a daily 1.5-2 hour instructional block for linking science and literacy (45 minute instructional blocks are used in K-2)
- Includes a variety of activities (hands-on, reading, writing/journaling, propositional concept mapping, project applications) focusing on core science concepts (big ideas)
- Multi-day lessons encompass activities through which students learn more about what they are learning
- Activating prior knowledge and cumulative review serve to facilitate student linking of new knowledge with that already learned

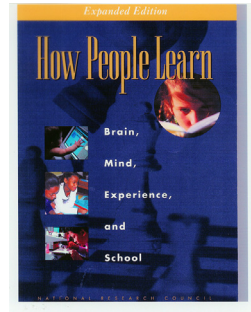
WHAT IS SCIENCE IDEAS?



Interdisciplinary Perspective on Meaningful Learning

Recent Research Related to Learning with Understanding (Bransford et al., 2000)...

- *Prior Knowledge* is a major determinant of future learning
- Understanding involves *organizing/re-organizing* knowledge around core concepts
- Learning involves *knowing* when to use prior knowledge and for future learning



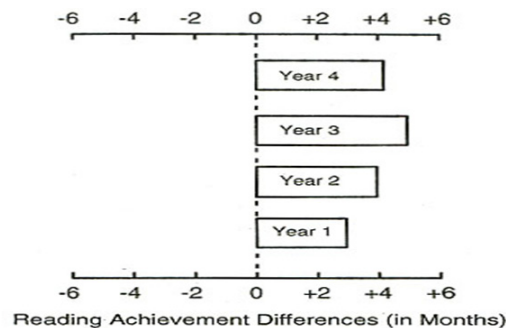
Science IDEAS Implementation Requirements

- Principal Oversees School Requirements
 - » Classroom Level
 - Science taught daily during an uninterrupted 1 ½ - 2 hour time block – thus providing ample time for
 - Hands-on inquiry lessons (first-hand investigations)
 - Journaling, writing explanations
 - Reading multiple sources
 - Constructing concept maps
 - Students not pulled from class during the Science IDEAS block
 - Students maintain science journals across entire year
 - Classroom libraries include science texts, non-fiction books and leveled readers
 - Evidence on walls and in hallways of teacher and student work (e.g., unit concept maps; writing from visuals)
 - Note: Language arts (using literary genre) taught for 30 minutes daily but not as part of the Science IDEAS block
 - » Schoolwide Level
 - Create a master schedule ensuring fidelity to time requirements
 - Organize (and facilitate) grade level planning for each new 9-week unit
 - Each grade (3-5) meets for 1 day of planning every nine weeks
 - Expanded to include K-2
 - Included a K-5 science articulation committee
 - Monitor teacher fidelity of implementation
 - Communicate vision for science learning
 - Use science as a context for learning team meetings, for school newsletter, for parent events (e.g., Parent Science Night)
 - Incorporate integrated science into the School Improvement Plan

Science IDEAS

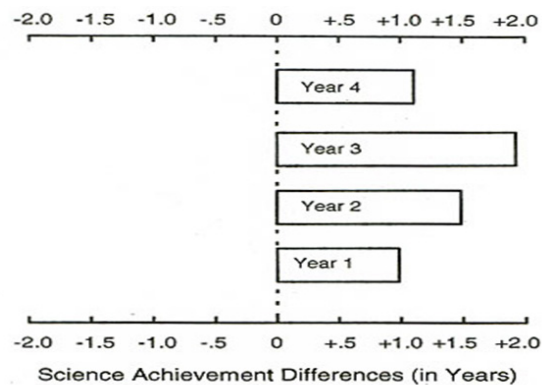
Patterns of Research Evidence: 1992-2001

Multi-Year Findings (ITBS/SAT Reading)



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

Multi-Year Findings (ITBS/SAT Science)



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 AND STUDENT ACHIEVEMENT

Overview of Science IDEAS Impact

- Major conclusion: Science IDEAS is effective in accelerating student achievement outcomes in science and reading comprehension in grades 3-4-5.
- The magnitude of the effects expressed in grade equivalents on nationally-normed tests (ITBS, SAT, MAT) were educationally meaningful
- Science IDEAS can be considered an effective replacement for basal reading programs that currently dominate instruction across grades 3-4-5
- Impact of the effects of Science IDEAS in grades 3-4-5 was transferable to grades 6-7-8.
- Science IDEAS model offers major implications for curricular policy at the elementary level (Vitale, Romance, & Klentschy, 2006)
- Adaptation of the Science IDEAS model was shown feasible for grades K-2 and effective with regular and at-risk students.
- Overall: Science IDEAS model has implications for changes in curricular policy that would link science and literacy in elementary classrooms (Romance & Vitale, 2008)

Research Evidence Extending the Impact of the Science IDEAS Model

Mini-Study in Grade 5: Exploring Reading Comprehension Strategy Effectiveness

Results: Science IDEAS (vs. Basal) obtained significantly higher achievement in Reading and Science (ITBS)

- Instructional Treatment main effects (Adjusted GE)
 ITBS Reading (Science IDEAS: +.38 GE)
 ITBS Science (Science IDEAS: +.34 GE)
- Main effect of Reading Comprehension Strategy Use not significant. However the interaction between Instruction and Reading Strategy Use was significant
- Simple effects analysis for Treatment x Strategy interaction showed Strategy Use enhanced Science IDEAS achievement impact an additional +.17 GE in Science and +.53 GE in Reading, but not for Basal Reading classrooms

Study conclusion: The reading comprehensive strategy was only effective when used with content-oriented instruction

Mini-Study in Grade K-2: Investigating the effectiveness of Science IDEAS in grades K-1 and 1-2

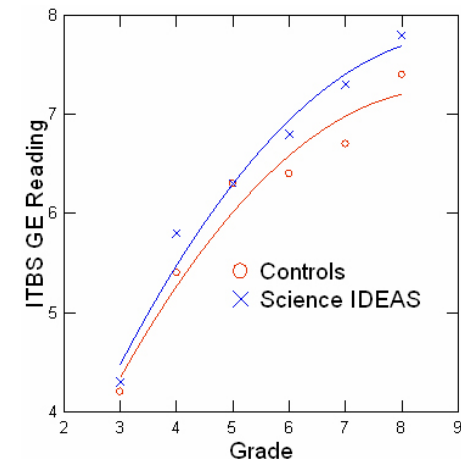
Results: Science IDEAS obtained significantly higher achievement in Reading and Science (ITBS)

- Treatment main effects (Adjusted GE)
 ITBS Reading (Science IDEAS: +.42 GE)
 ITBS Science (Science IDEAS: +.28 GE)
- Other significant effects for ITBS Reading (Adj. GE)
 Contrast- Ethnicity Differences: White vs. Non-White (White: +.38 GE)
- Simple effects analysis for Treatment x Grade Interaction showed magnified effect of treatment in Grade 2 (Science IDEAS: +.72 GE), no effect in Grade 1

Study conclusion: In-depth science instruction using adaptation of Science IDEAS model was feasible and effective in primary grades.

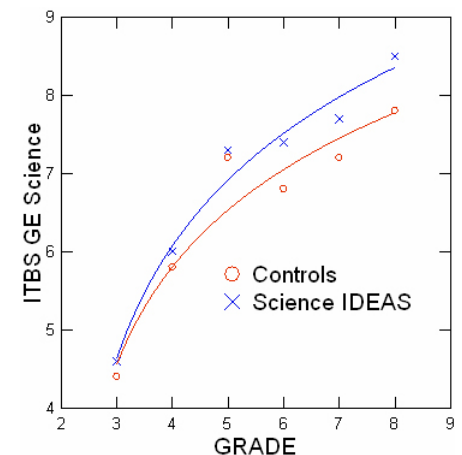
Patterns of Research Evidence: 2002-2007

» Grades 3-8: Student Achievement Trajectories in Reading



Note- Figure shows adjusted GE means on the ITBS Reading subtest for the Science IDEAS and Control students by Grade Level. Covariates were Gender and At-Risk status. Difference between Science IDEAS and Control students was significant, $F(1, 7145) = 22.53, p < .001$. The Treatment x Grade Interaction, was not significant. Girls out-performed Boys in Reading, $F(5, 7145) = 24.14, p < .001$.

» Grades 3-8: Student Achievement Trajectories in Science



Note- Figure shows adjusted GE means on the ITBS Science subtest for the Science IDEAS and Control students by Grade Level. Covariates were Gender and At-Risk status. Difference between Science IDEAS and Control students was significant, $F(1, 6457) = 18.8, p < .001$, as was the Treatment x Grade Interaction, $F(5, 6457) = 4.81, p < .001$ supporting the increasing differences in performance with Grade Level.

Overarching Goal of K-5 Science IDEAS

To provide in-depth science instruction across grades K-5 that prepares students to be successful in science and reading comprehension in middle/high school and beyond.

Science IDEAS: Interdisciplinary Principles

1. Use the logical structure of core concepts in science (e.g., NGSS) as the basis for a grade-articulated curricular framework.
2. Insure the curricular framework provides a firm foundation essential for maximizing comprehension of “new” content to be taught.
3. Provide adequate time to achieve cumulative conceptual understanding emphasizing “students learning more about what they are learning”.
4. Guide student conceptual organization of knowledge by providing experiences with the six Science IDEAS elements (e.g., engaging in multiple hands-on investigations/activities, reading across multiple sources to gather, link, and communicate new knowledge [e.g., CCSS]).
5. Provide students with opportunities to represent the structure of conceptual knowledge across cumulative learning experiences as a basis for oral and written communication (e.g., propositional concept mapping, journaling/writing, applications) emphasizing evidence-based claims, argumentation, analysis.
6. Reference a variety of conceptually-oriented tasks for the purpose of assessment that distinguishes between students with and without in-depth understanding (e.g., distinguishing positive vs. negative examples, using IF/THEN principles to predict outcomes, applying abductive reasoning to explain phenomena in terms of science concepts).
7. Incorporate the use of in-depth, meaningful, cumulative learning science as a necessary foundation for developing student proficiency in reading comprehension and written communication

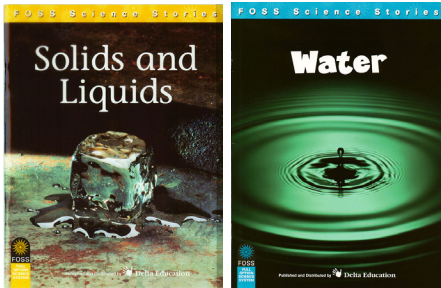
Science IDEAS Scale-Up

- General Perspectives on Scale Up
 - » Intervention evolution - Initiation, sustainability, expansion
 - » Multi-phase scale up sequence- capacity development, added value, organizational infrastructure development, transfer of implementation responsibility
- Science IDEAS Scale Up Project (NSF/IERI)
 - » Project goal - to provide support necessary to implement Science IDEAS model in an increasing number of schools (from 2 to 13 schools - in grades 3-5) as a means for studying scale-up
 - » Project design strategy - to develop and validate a model implementation system for scale-up of Science IDEAS that provides all components needed by school systems to assume implementation responsibility for sustainability and expansion of the Science IDEAS model
- Major Scale Up Initiatives - Building School Capacity and Infrastructure for Sustainability and Expansion
 - » Specialized Teacher Expertise
 - Science content understanding
 - Science IDEAS implementation
 - » Teacher Leadership Cohort
 - Serve as in-school mentors and problem solvers
 - Organize and deliver summer institutes
 - Serve on school and district curricular committees
 - » Principal Leadership for Science IDEAS
 - Support for and management of grade level curricular planning development
 - Monitoring implementation fidelity
 - » District Management Capacity and Infrastructure
 - Computer-based systems for monitoring implementation status
 - Conduct direct observations of school classrooms and professional development.

Science IDEAS

SIX INSTRUCTIONAL ELEMENTS

Reading Comprehension



Reading Multiple Sources on a Topic – Building Additional Background Knowledge

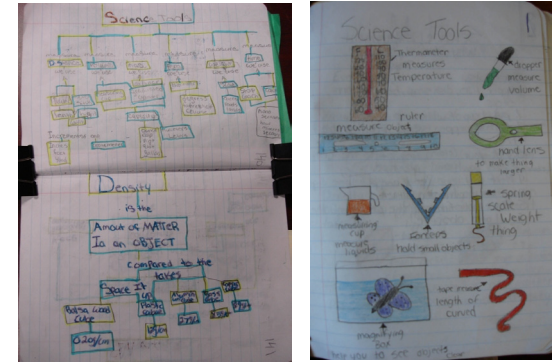
Conceptual Development Emphasis: Learning more about what is already known broadens and deepens knowledge. Teachers apply the Science IDEAS Reading Comprehension Strategy for all whole-class reading assignments.

For each major unit/topic, students read up to 10 sources on a specific or related topic. After reading, students communicate what they have learned using a variety of formats (e.g., “30 Ways to Share a Non-Fiction Book”).

Prior Knowledge / Cumulative Review

All cumulative meaningful learning is based on a foundation of prior knowledge. In Science IDEAS, teachers enhance student accessibility of prior knowledge as a context for instruction through two complementary strategies: Prior Knowledge and Cumulative Review. In the Prior Knowledge strategy, teachers query students about prior learning and experiences relevant to a topic to be taught. In the Cumulative Review strategy, teachers focus student attention on prior curricular knowledge students have been learning about over a period of weeks. In Science IDEAS, Prior Knowledge typically is used as a lesson introduction, while Cumulative Reviews are scheduled on a 4-6 week basis throughout the school year.

Writing Activities / Journaling



Examples of student generated propositional concept maps as they appear in journals

Student journal entries illustrating science apparatus and their uses

Science Activities

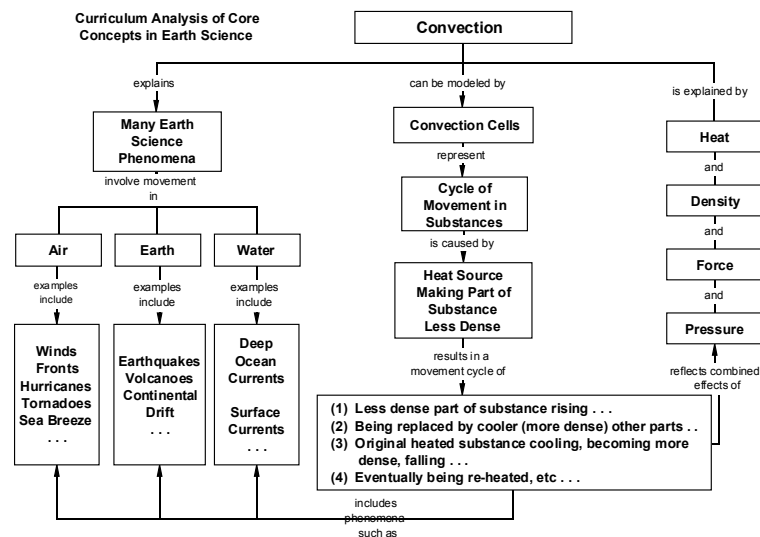


Meaningful Learning Supported by Classroom Interaction and Discussion

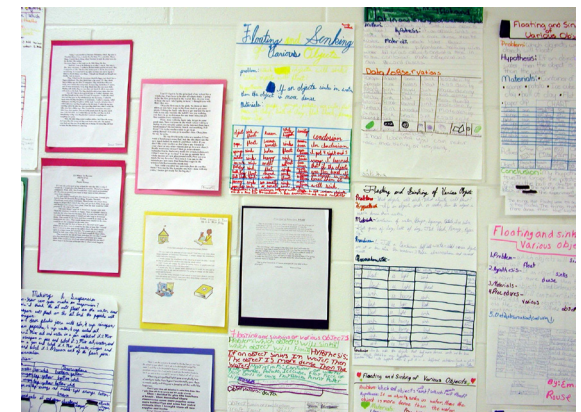
Students collect and analyze data and record their observations (meaningful writing about science)

Discussions help to extend, re-organize and summarize information garnered from multiple sources

Propositional Concept Mapping



Application Activities



Multiple Formats for Writing to Learn

Teachers guide student use of journaling, note-taking, making observations, recording data, reporting and displaying work.

Teacher Professional Development

- The purpose of the Teacher Professional Development is to prepare teachers for effectively implementing Science IDEAS, an integrated instructional model linking inquiry-based science focused on a core concept framework with forms of literacy designed to deepen student learning in science and reading comprehension.
- Across each year of the project, elementary science classroom teachers participate in Science IDEAS institutes according to the following schedule: Year one – 10 days summer, 5 days school year; Year two – 5 days summer, 4 days school year; Years three and four – 2 days summer, 2 days school year. Year five- teachers participate in advanced training opportunities.
- Additional professional development was added to the project at the request of primary (K-2) classroom teachers. K-2 teachers received 3 days annually of professional development.



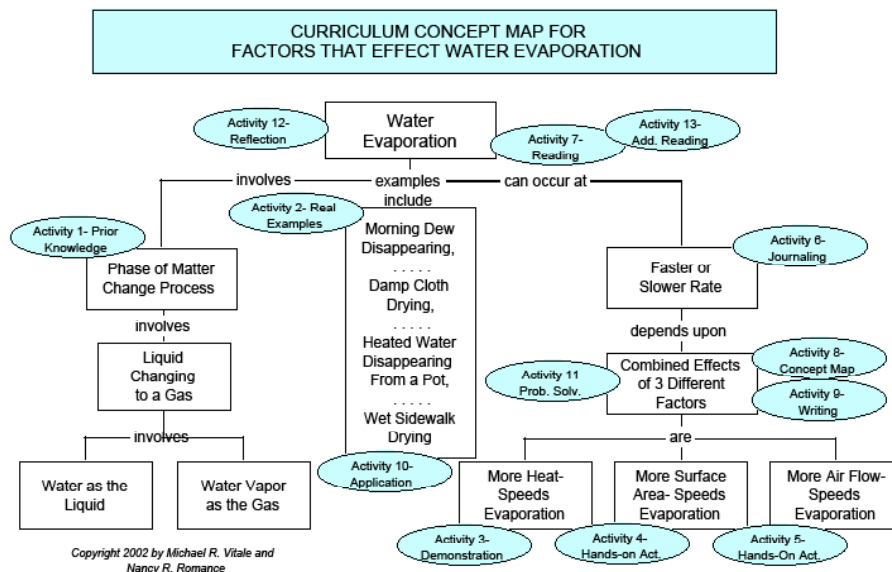
Areas of Emphasis:

- Building teacher conceptual knowledge in science
- Experiencing inquiry science - including building a repertoire of hands-on activities
- Constructing propositional concept maps
- Setting up their own science journal
- Building a community of science learners

Grade Level Planning

- The purpose of project-required grade level planning is for teachers to plan out science curriculum units (i.e., propositional concept map or maps) focused on core concepts and aligned with state science benchmarks
- Teachers use Science IDEAS Curriculum Resource Binders as well as the 2009 Next Generation Sunshine State Science Standards (Big Ideas Explained)
- Implementation of the grade level planning occurs for a full-day every 6-9 weeks and includes all teachers at a specific grade level across K-5
- Following construction of the Curriculum Unit, teachers identify how the six elements of Science IDEAS can be used to support meaningful, in-depth student learning
- Teachers also identify key resources (e.g., inquiry activities, journaling experiences, science texts and trade books focused on unit concepts, technology, field trips)

Constructing Propositional Concept Maps to Build Science Curriculum Units



Classroom teachers use grade level planning time to construct conceptually-organized propositional concept maps for instruction, assessment, and student use (e.g., as a blueprint for expository writing). Teachers use multiple sources in creating maps.

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Linking Science and Literacy in K-5 Classrooms

Benefits to Teachers

- Links literacy with science to maximize use of instructional time
- Increases opportunities to address non-fiction reading (CCSS) standards
- Supports a coherent approach to student learning with understanding (comprehension)
- Aligns with School District's emphasis on Literacy and STEM standards
- Builds needed background knowledge to support struggling at-risk learners as they learn to comprehend non-fiction materials
- Provides rich opportunities for active engagement of all learners
- Nurtures the development and reinforcement of key content-area reading skills
- Provides a supportive framework for teachers to link hands-on inquiry with core concepts being learned through reading

Benefits to Students

- Provides multiple opportunities for hands-on inquiry activities
- Supports learners in linking their science investigations with the underlying core concepts through use of content-area reading materials and writing/journaling to learn
- Provides a meaningful context for students to write (and publish) their own informational text
- Uses an integrated approach to support student understanding of the world around them
- Engages students in using the practices of science (e.g., claims, evidence, arguments, designing investigations) within an authentic learning context
- Supports development of domain knowledge and vocabulary to support comprehension, classroom discourse, and scientific literacy

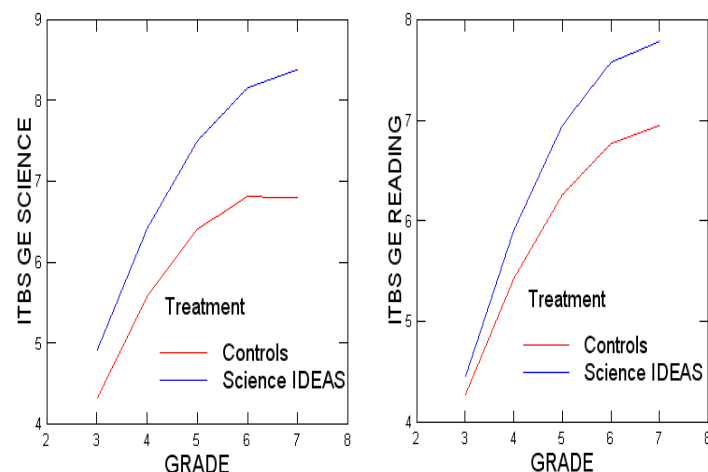
Adaptations of Science IDEAS to Grades 1-2

An important project initiative within the Science IDEAS project was to explore the potential of adapting the grade 3-5 model to grades K-2. This adaptation consisted of modifying the six Science IDEAS elements to make them "age-appropriate". The K-2 implementation consisted of 45 minutes per day of science instruction (i.e., reading/language arts were not modified).

In the 8-week mini-study reported on page 3, the modified model had a significant effect overall on ITBS Science, but only in grade 2 on ITBS Reading. However, in a follow-up expanded year-long study, the model did have a significant effect on both ITBS Science (+.16 GE) and Reading (+.58 GE). The authors are presently conducting a large-scale study funded by NSF DRK12 (2013-2017) to establish the direct effects of the model in grades 1-2 and the transfer effects to grade 3.

Science IDEAS: Grade 3-7 Replication

The figures below show the findings of a grade 3-7 follow-up study (2003-2008) to the original grade 3-8 study (2002-2007) presented on page 3. HLM findings found significant main effects and grade x treatment interactions for both ITBS Science and Reading. These follow-up findings are supportive of both the direct and transfer effects of the model from grades 3-5 to grades 6-7.



Project Investigators

Dr. Nancy Romance (PI)

Florida Atlantic University

Dr. Michael Vitale (Co-PI)

East Carolina University

Dr. Jerome Haky (Co-PI)

Florida Atlantic University



NSF/IERI Science IDEAS Project, Florida Atlantic University, College of Education, 777 Glades Road, Boca Raton, FL 33431
Phone: (561) 297-3577, Fax: (561) 297-3794, Web: www.scienceideas.org

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