Transformative Impact of Engaging Early Learners in Science and Literacy on Achievement Outcomes in Grades 1-2 and Beyond

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Research Questions

1. Were teachers able to implement Science IDEAS with fidelity in ‘authentic’ classroom settings?
2. What was the effect of implementing Primary Science IDEAS on students outcome measures in science and reading? How did student outcomes compare to control classrooms?
3. Did teachers’ perceptions of the quality of the professional development link favorably to their confidence in terms of classroom implementation of the model?
4. What aspects of the professional development were the most valuable (qualitative comments)?

Science IDEAS Model

Integrating Literacy within K-5 Science

Preparing To Teach Primary Science IDEAS: Professional Development Model -- Building on Best Practices

- **Focus of PD**: Building teacher background knowledge in science; focused content-area literacy; proficiency in classroom instruction using the Primary Science IDEAS Model in grades1-2
  - **Workshop schedule –** On-going across years 1-2-3.
    - Year 1: 3 days -- academic calendar; 5 days summer
    - Year 2: 4 days -- academic calendar; 4 days summer institute
    - Year 3: 3 days -- academic calendar
- **Characteristics of PD**
  - Directly linked to district curriculum (job-embedded)
  - Built teacher confidence in understanding science core concepts and practices (outcome expectation)
  - Built teacher confidence in linking science and literacy (teaching expertise)

Preparing To Teach Primary Science IDEAS: Characteristics of our Professional Development Model

- **Characteristics of the PD Model:**
  - **Content-based Focus**: Understanding core disciplinary concepts (NGSS), *linking core concepts to other topics in science* (e.g., heat energy in phase change, in explaining changes in weather), cross-cutting concepts and using the practices of science
  - **Pedagogical Focus:** Knowledge-Based Instruction – KBI:
  - Science: Planning - step 1 - concept mapping; step 2 - design/select investigations focused on concepts identified on concept map; step 3 - link concepts to everyday examples, step 4 – stress forms of communication (discussion, journaling, displays) to make sense of observations and linking them to the underlying science concept
  - **Pedagogical Focus**: Knowledge-Based Reading Comprehension Routine – KBC
  - Reading: Integrate use of science trade books (e.g., 10 books for each unit.)
  - Writing: Integrate various writing genres; link writing to understanding science concepts and having students express their understanding and explanations; use science journals (plus students creating their own informational books)

Science IDEAS: A Model for Integrating Literacy with In-Depth Science Learning

Element # 1
Science Investigations

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- **Science inquiry (first-hand investigations)are aligned with Practices of Science (POS) and the Disciplinary Core Ideas (DCI's)**

- All first-hand investigations are linked with reading and writing more about the topic (CCSS)

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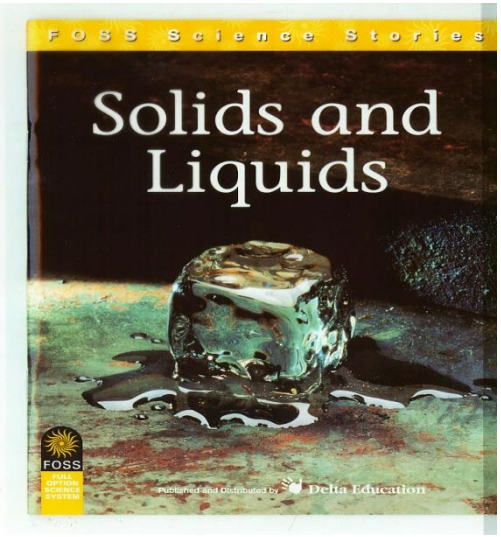
Element # 2

Reading Comprehension

- **Reading (second-hand investigations) -** students are first guided in reading about the topic, then they are able to read additional non-fiction books related to the science concepts being learned (District Literacy Standards and CCSS)



Students are learning more about what they already know! This has a major impact on comprehension and writing. Recommended is the reading of up to 10 books related to the lesson topic/concepts. Strategies used include our KBC model, guided reading, close reading, paired reading, and independent reading.

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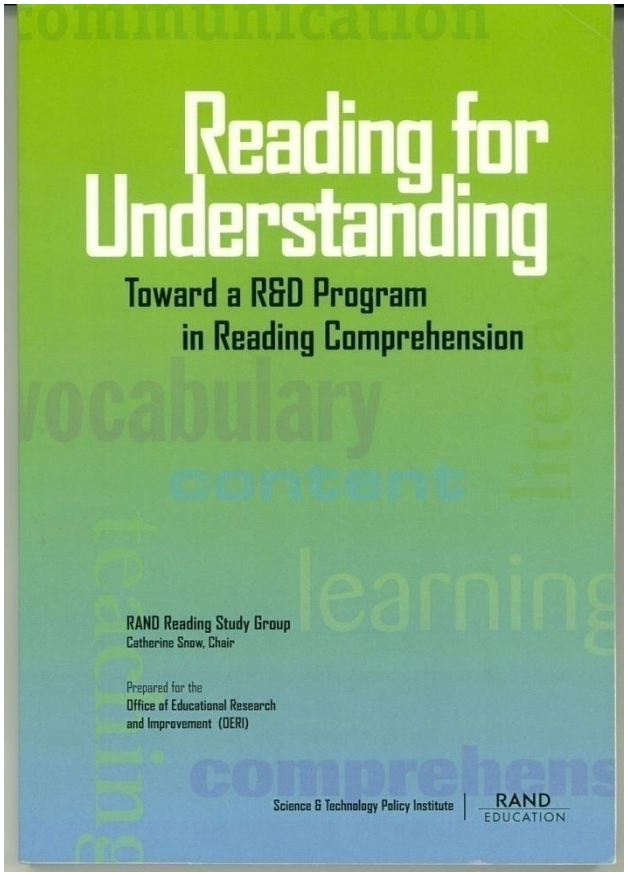
Element # 2 Reading Comprehen-sion

[What we can Learn from the Rand Report]

Research Findings

- Recommends the need for much more focus on content-area reading comprehension (as does the CCSS and NAEP)
- Provides an excellent definition of comprehension, namely that… *comprehension is the simultaneous process of extracting and constructing meaning from text*



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Element # 3
Writing and Journaling

- Writing and Journaling are specifically aligned with the science concepts being learned.

- Students can use a wide variety of writing genres (e.g., describe steps followed in their investigations, make claims, gather and record evidence, and draw conclusions).

- Students can write their own informational books, posters and other literary exhibits (District Literacy Standards and CCSS)

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Element # 3 Writing and Journaling

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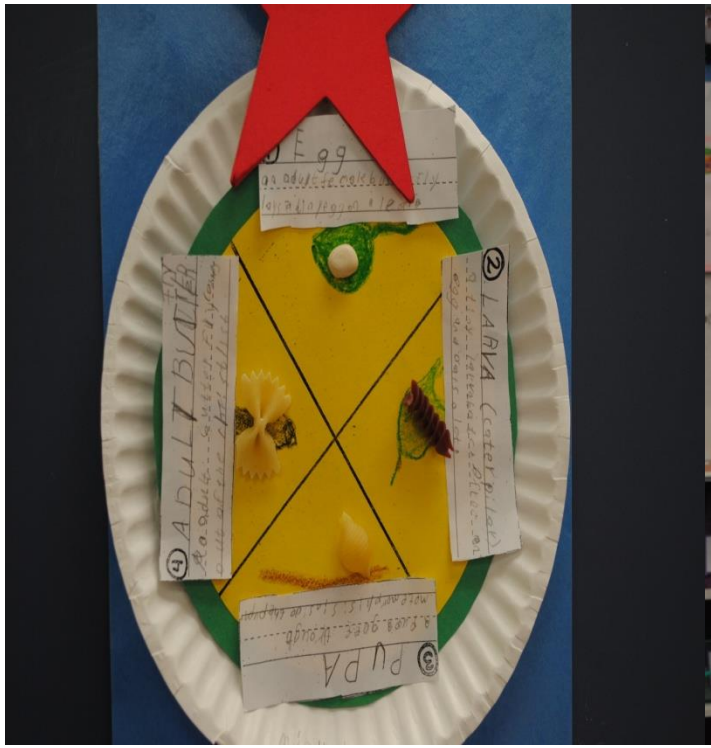

Students labeled and described the life cycle of a butterfly (Grade 1)

Student created her own informational book and a diorama that include the panda bear (Grade 1)

Science IDEAS

Element # 3 Writing and Journaling

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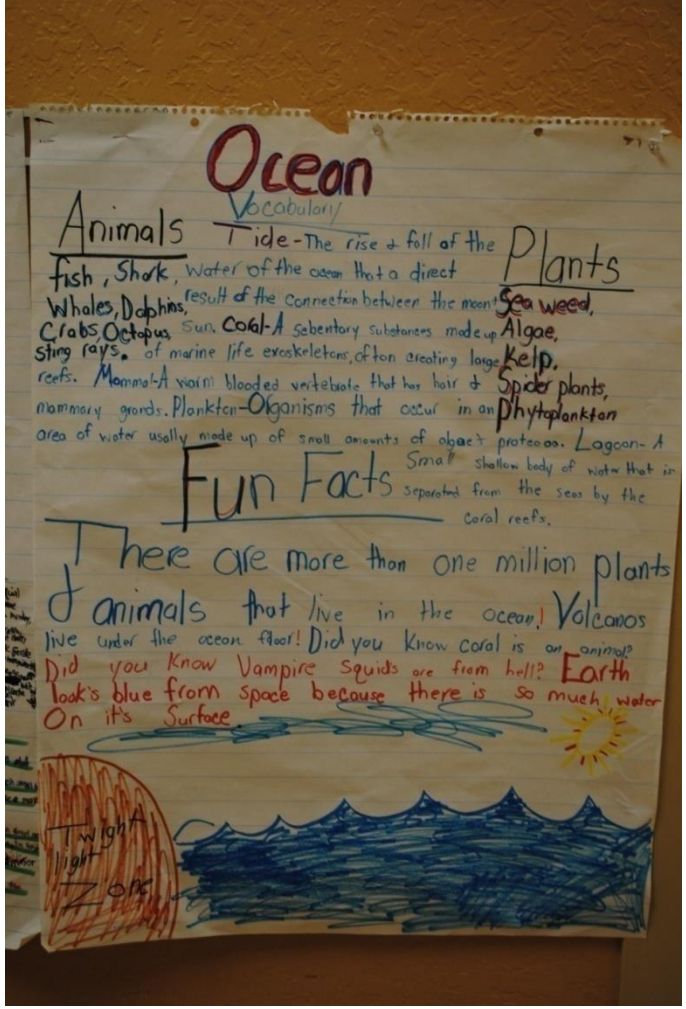
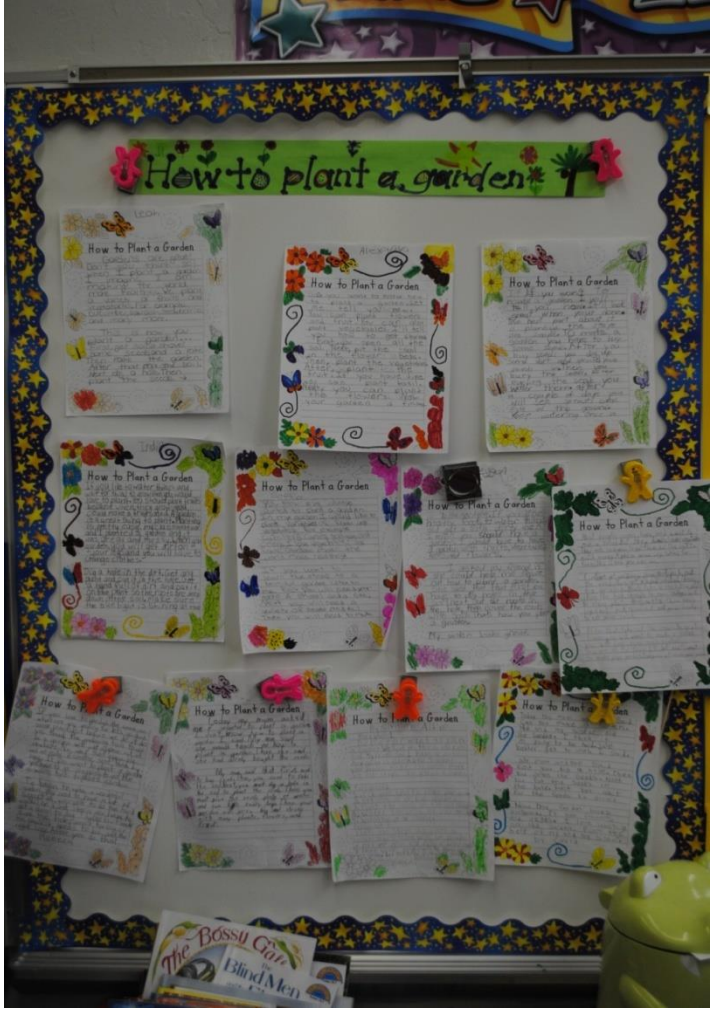


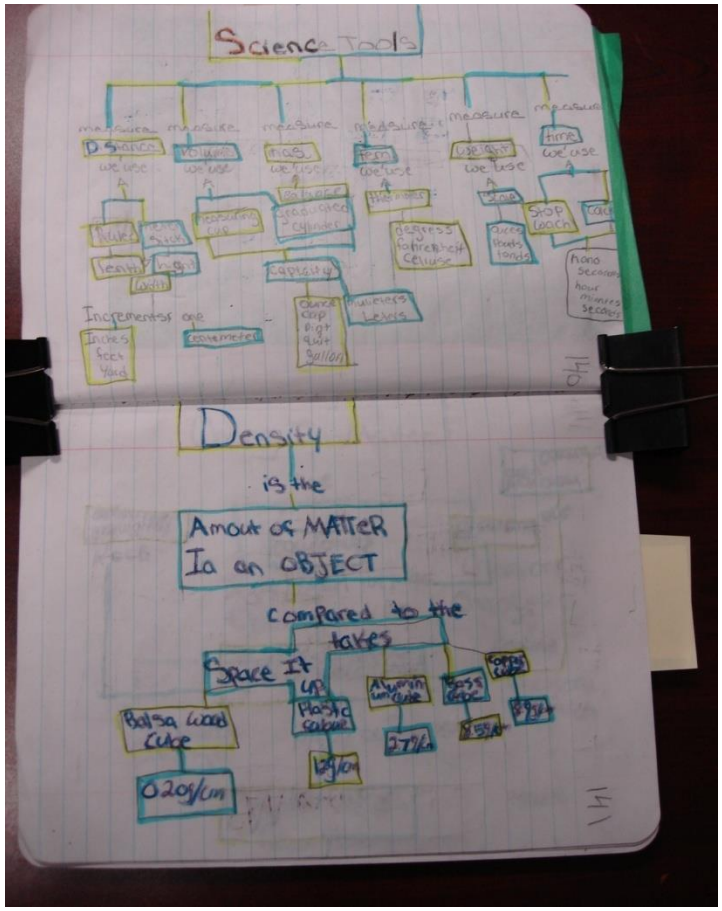
Students created informational posters highlighting key science concept words (vocabulary), examples of living organisms, fun facts (Do you know why the Earth looks blue from space? Grade 2

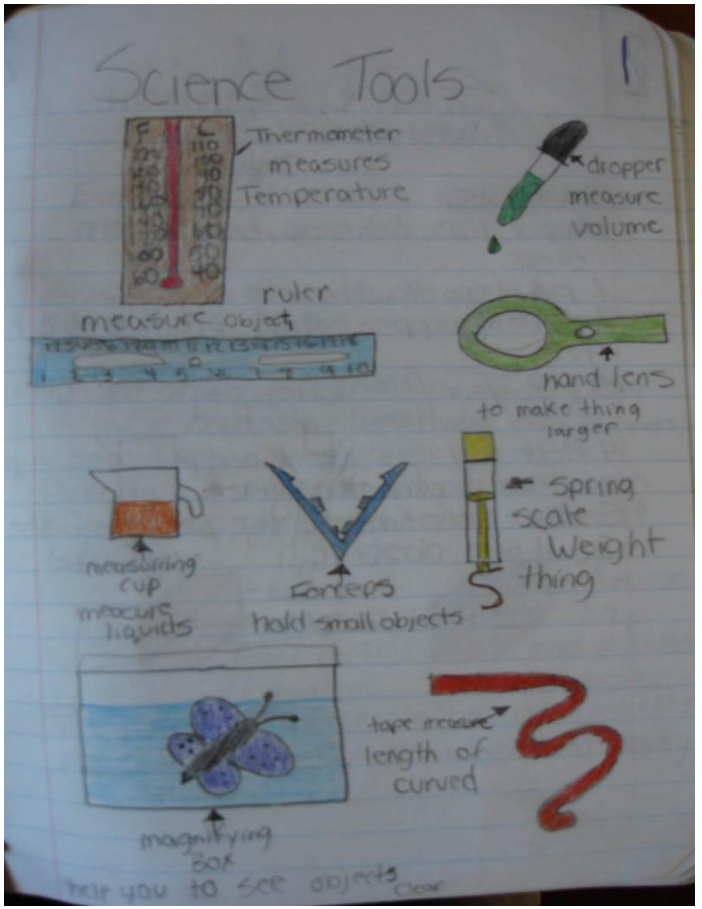


Upon completion of a hands-on gardening experience, each student wrote suggestions for How to Plant a Garden? Grade 2

Student Science Journal

Element # 3 Writing and Journal -ing





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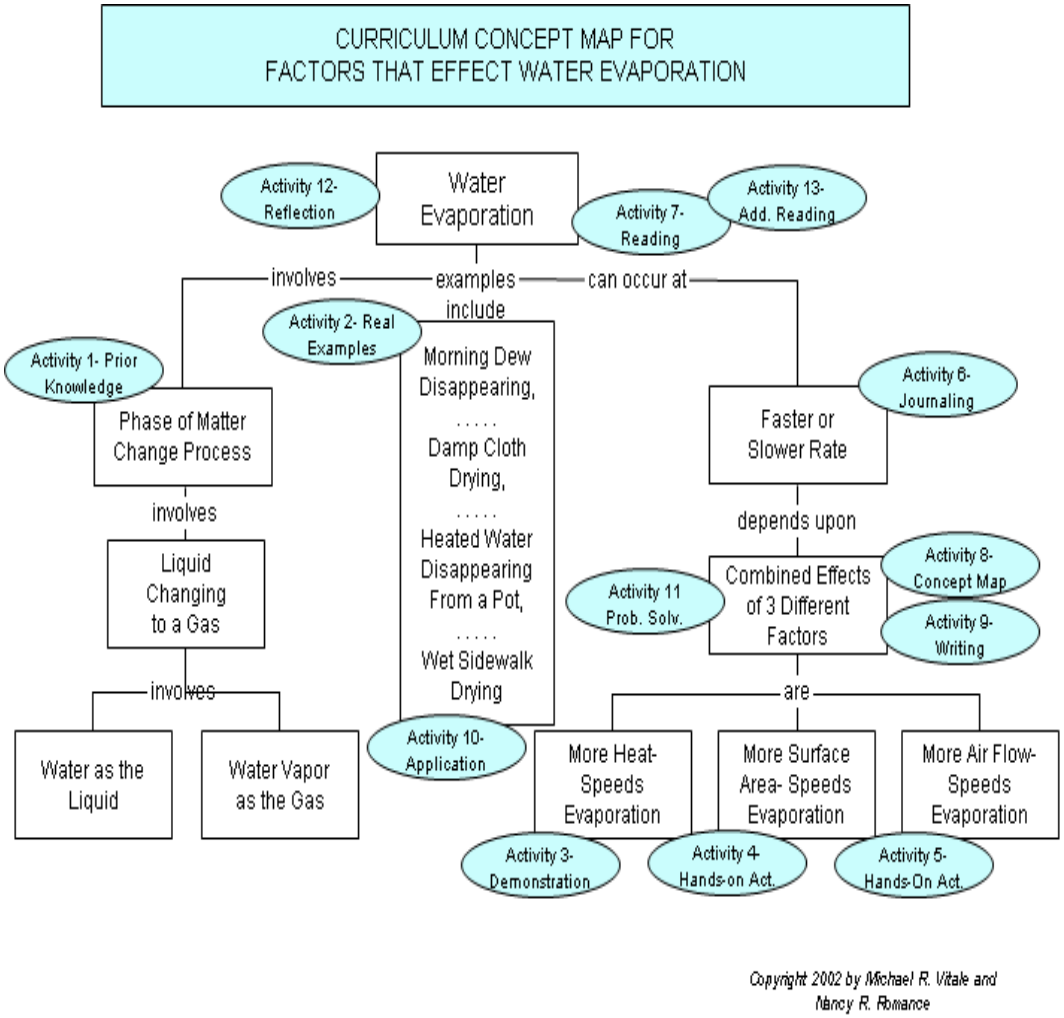
Propositional Concept Maps:

The Starting Point for All Curriculum Units

Element # 4 Propositional Concept Mapping

- Propositional Concept Mapping:
- For teachers – they identify and organize the key science concepts to be taught.
- For students, they are an important step in deepening comprehension and for expository writing.
- Links CCSS; FL's and NGSS)



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Propositional Concept Maps

Element # 4
Propositional Concept Mapping

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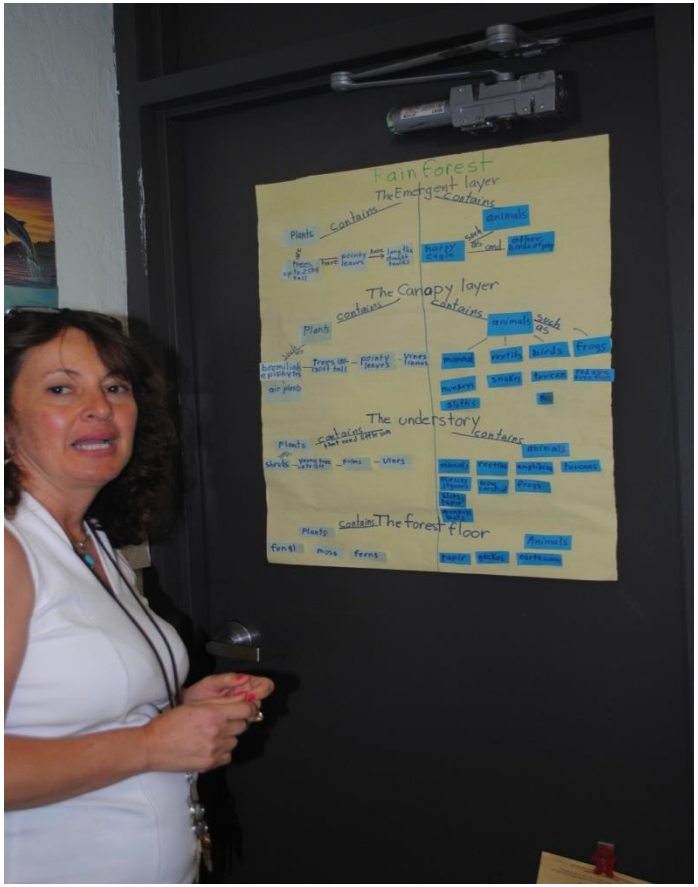
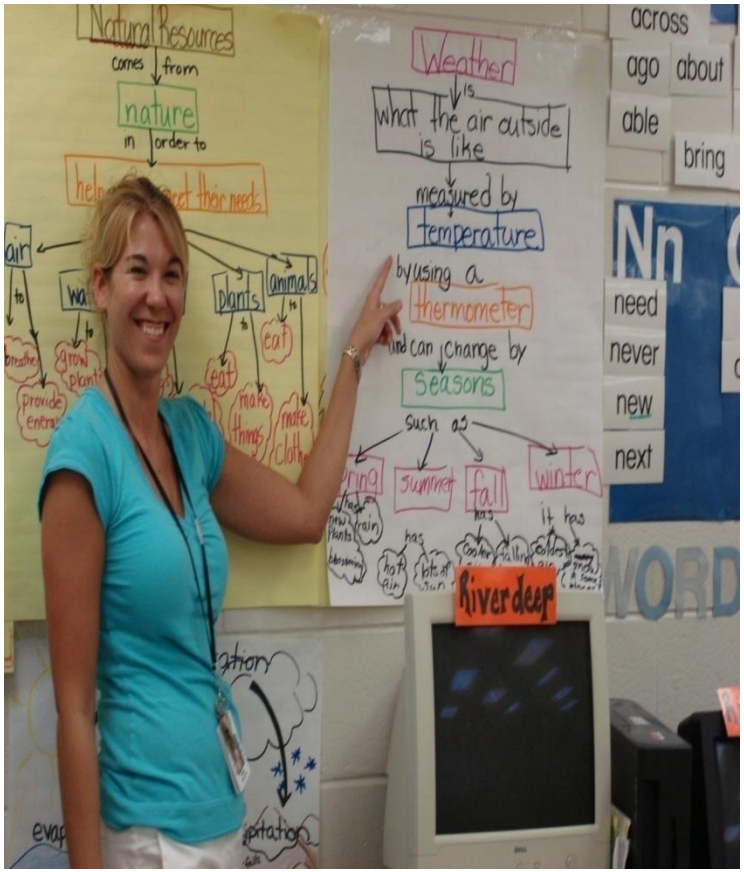


2nd grade teacher explains how the students suggested to organize the class map on the rain forest



2nd grade teacher (2003-2008) builds map with students as lesson evolves

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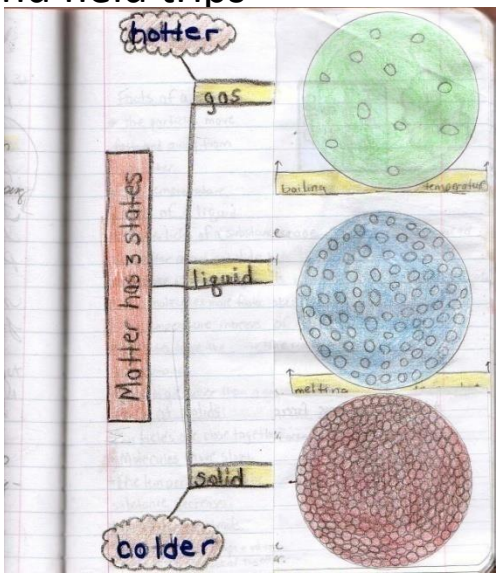
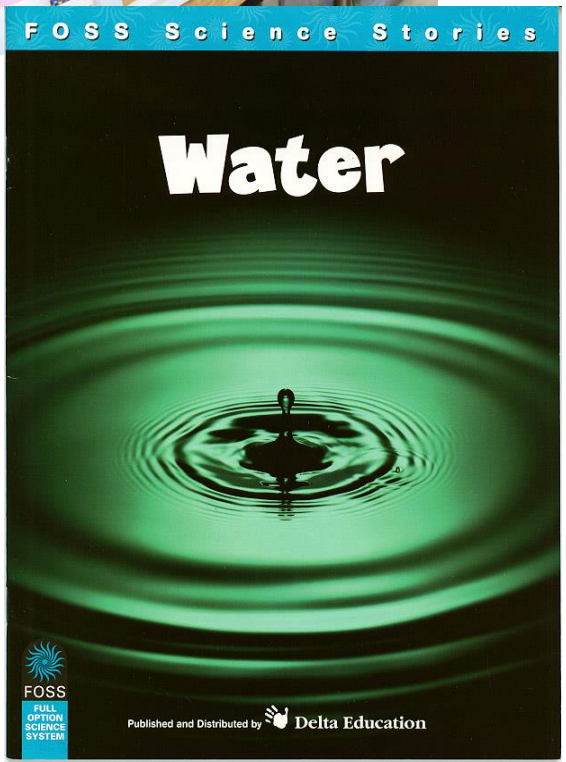
Element # 6
Application

Application activities may include any combination of new

- Hands-on investigations
- Writing and Journaling
- Reading additional books and related narrative non-fiction (10 recommended)
- Revisions of the concept map
- Novel projects and field trips





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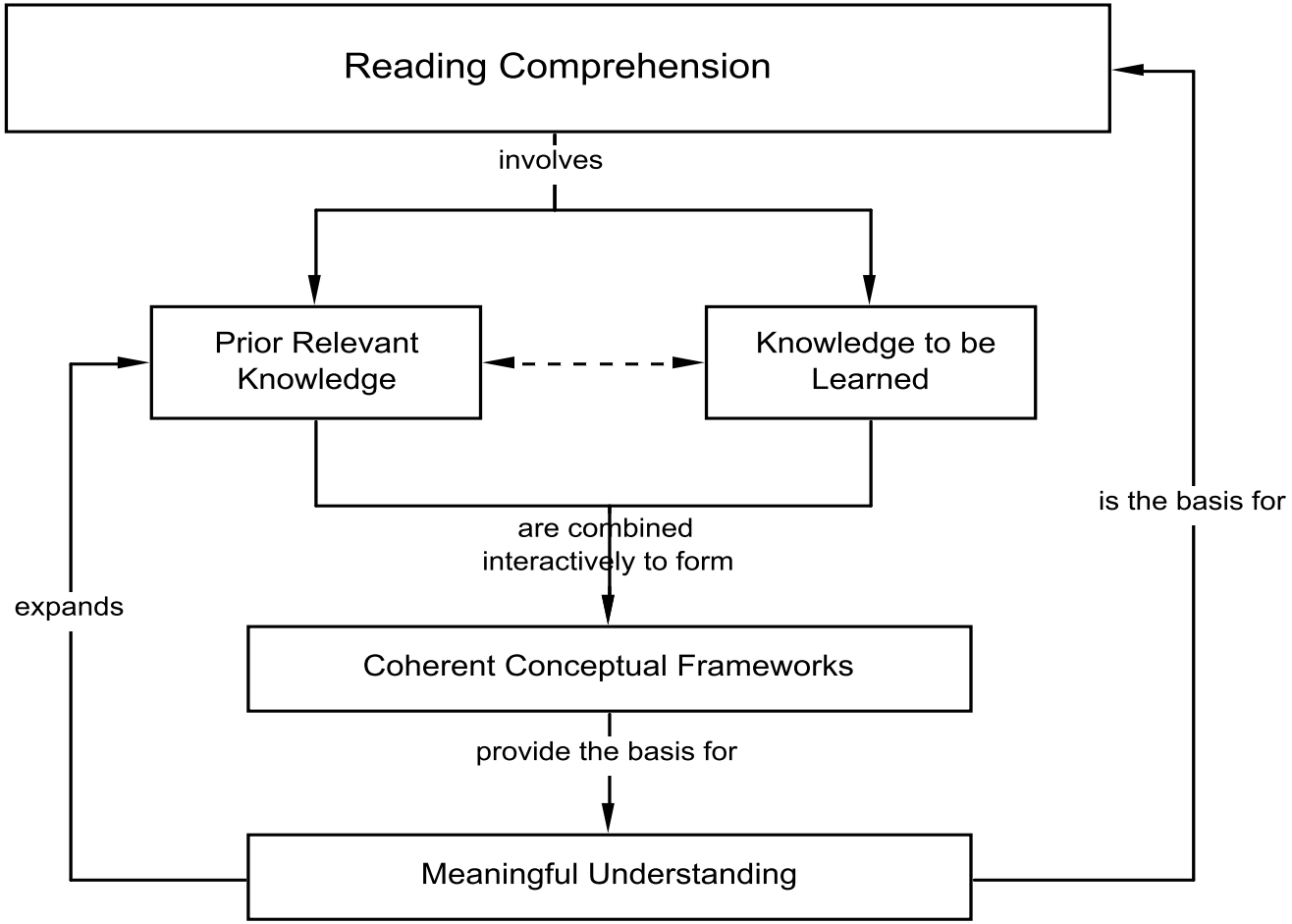
Science IDEAS Model

Content-Focused Perspective for Addressing Reading Comprehension



Science IDEAS Model:
"Building Meaningful Comprehension with Frequent Use of Science Informational Text"

Science IDEAS Model …Literacy Guidelines

- Has a specific knowledge-based reading comprehension strategy that teachers learn then apply while teaching
- Align with the broad goals implicit within both the CCSS (informational literacy)
- Actively engage learners in "…thoughtful engagement with high quality informational texts that builds knowledge, links to hands-on investigations, …" and supports reasoning and evidence-based discussion and argumentation
- Advocate for frequency and dosage (i.e., more often, more time)

Science IDEAS Model

What to do with Science Informational Text?

Previewing the Text: In order to guide the learner (guided reading), you, yourself, must know *how the concepts in the text are organized and presented.*

Prior Knowledge and Experience Support Comprehension: To guide student comprehension of text, it is important for you to guide students *to access on a continuing basis what prior curricular knowledge they have and what relevant everyday experiences that they have that they can draw upon.*

Grade 5
LAFS.5.W.3.8

Science IDEAS Model
What to do with Science Text?

- Two key strategies to apply when guiding student reading comprehension using informational text:
  - Strings of simple sentences – common in elementary science text do not support comprehension for early learners
    - Read-and re-read combining sentences
    - Re-write by combining sentences across paragraphs
  - Complex sentences with embedded clauses make comprehension difficult
    - Discuss with students how to parse complex sentences and then put them back together (e.g., key words are a clue to cause/effect relationships)
    - As an example: Because particles that make up water can slide easily past each other, water can flow to fit the shape of a container.

Research Design: Year 3 - NSF Project

- **Grade 1-2 *Science IDEAS* intervention - Experimental**
  - District Science and Reading curriculum across an entire year in grades 1-2
  - Involved 45 minutes of integrated science/reading/writing/day
  - Included all regular, self-contained teachers at a grade level
  - Provided teachers with 5-days summer and 4 days – academic year – Professional Development
  - Involved monitoring classrooms for fidelity
  - Involved teacher-administered ITBS Science and Reading and FL Benchmark Science Test (N=5/Classroom)
- Grade 1-2 Control
  - Same science and reading curriculum; District PD; up to 30 minutes – science; opportunities for District Summer Science workshops; same testing; observed 2 x per year

Year 3 – Teacher Measures

- Measures of implementation fidelity
  - Quality of implementation
    - Degree to which model was consistently implemented (quality)
  - Adherence/Dosage
    - Formal observations – 3x during year
    - Informal observations – during school visits
    - Cronbach Alpha reliabilities for this scale component ranged from .78 to .84.
  - Level of student engagement/interest
  - End-of-Year Teacher Survey

Year 3: Student Measures

Nationally-Normed Assessments

Science: ITBS Science Achievement (Levels 7 & 8)

Reading: ITBS Reading Achievement (Levels 7 & 8)

Project Developed Assessments

- **District/FLNGSSS Benchmark Science Understanding**

  25 Item Test - items consisted of a question orally presented by teachers. Students chose one of three possible answers in picture form. Cronbach Alpha reliabilities for the tests were .85 and .91 for grades 1 and 2, respectively.

Year 3: Year Long Study Design

- **HLM analysis**
  - **Level 1 Predictors** (Grand-Mean-Centered)
    - Ethnicity (African American, Hispanic, White)
    - Gender (Male, Female)
    - Note- SES (Free/Reduced Lunch)
  - **Level 2 Predictors**
    - Treatment (*Science IDEAS* vs. Controls)
    - Grade (1, 2)
- **Analysis notes**
  - Separate HLM analyses for ITBS Reading, ITBS Science, Benchmark Science Understanding

Year 3 NSF Teacher Results

End of Year Teacher Survey

Assessed **three categories** relating to PD-Support for Implementing Primary Science IDEAS Model:

- Did teachers recognize that student understanding of science concepts engenders literacy proficiency,
- Were teachers able to apply PD-based classroom strategies for implementing the integrated model, and
- Did the positive effects of their participation in the PD engender their professional perspectives on the effectiveness of the model.

Findings: Teacher responses across each category were highly positive, ranging from 94-100 percent agreement.

Fidelity of Implementation by Teachers

Classroom observation following 12-week cycles found, on average, the overall fidelity of implementation of 84% in grade 1-2 classrooms over the school year.

NSF - Year 3 - Student Results

ITBS Science Achievement

- Significant effect for ITBS Science (Adjusted Treatment = + .54 GE, $t(190) = 4.46$, $p < .001$, Hedges $g = .48$)

ITBS Reading Achievement

- Significant effect for ITBS Reading (Adjusted Treatment = + .11 GE, $t(190) = 2.149$, $p < .033$, Hedges $g = .37$)

Benchmark Science Understanding

- **Grade 1**: Significant effect for grade 1 BSU (Adjusted Treatment = + .049 Pct. Correct, $t(91) = 4.24$, $p < .001$, Hedges $g = .46$)
- **Grade 2**: Significant effect for grade 2 BSU (Adjusted Treatment = + .05 Pct. Correct, $t(98) = 3.29$, $p < .001$, Hedges $g = .41$)

Note- No interactions were found between student demographic variables and treatment for any analyses.

NSF - Year 3 – Overall Study Conclusions

- **Study Conclusions: Science IDEAS in Grades 1-2**
  - Model was feasible for regular classroom teachers to implement with fidelity
  - Effect of model on achievement was consistent across gender, ethnicity, and grade levels (no treatment interactions)
  - Finding suggest Science IDEAS instruction resulted in significant “added value” to grade 1-2 instructional program and suggests more time can feasibly be allocated to an integrated science and literacy program in early grades

Implications – Policy & Practice

- K-5 science experiences should be a KEY element in the reform of elementary school teaching and learning
  - Strong evidentiary base demonstrating powerful outcomes in support of linking reading comprehension (and writing) and science (Romance & Vitale, Pearson, Hiebert, French, Gelman, Greenfield, Hirsch)
  - Early engagement in science (pre-K-K) determines student success in science in grade 3 and grade 8 science as well as serving as an factor in subsequent economic well-being and career growth (Morgan, et al., 2016)
  - Early science builds fluency, self-regulation, (executive function), and critical thinking,
  - Lack of early science learning manifests itself in the continuing decline in student achievement from grades 5-12 in both science and reading (NAEP)
  - Generally, enhancements and increases in dosage of reading (including high dosages of non-content-rich materials for struggling readers) does not hold up in terms of improvement on state accountability and nationally-normed measures – NAEP (especially above basic and proficient)