An Interdisciplinary Framework for the Design of Instructional Practices to Advance Student Achievement in Science and Literacy in Grades K-5

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Overview

In considering the primary academic goal of K-5 instruction as the preparation of students to be successful in future secondary, content-area courses, this poster reports multi-year findings that apply consensus interdisciplinary perspectives toward the establishment of a synergistic relationship between science and literacy (see Pearson et al., 2010). Such interdisciplinary perspectives provide a powerful framework for instruction that supports (a) the integration of literacy with science and (b) implications for changing K-5 curricular policy to increase time for science.

As an interdisciplinary approach, the Science IDEAS model embeds literacy within conceptually-oriented science instruction in grades K-5. The model follows an architecture which employs a core science conceptual framework to identify, organize, and sequence all instructional activities within science (e.g., reading comprehension, journaling/writing, propositional concept mapping, inquiry-oriented activities) across multi-day lessons.

The *Science IDEAS* model evolved as a general instructional approach feasible for use in regular classroom settings in which reading/language arts are combined with time-expanded, conceptually-oriented science instruction. In grades 3-5, the *Science IDEAS* model is implemented through a daily 1.5 - 2.0 hour instructional block that *replaces* traditional reading/language instruction (literature is scheduled at a different time during the school day). In grades K-2, the Science IDEAS model is implemented through a daily 45 minute instructional block (traditional reading/language arts are *not* replaced in grades K-2).

Diverse Research Relatable Through Interdisciplinary Perspectives

Anderson, 1996; Bransford et al. 2000; Cervetti & Pearson, 2006; Dick et al. 2008; Dillon & Tan, 1993; Duke et al. 2007; Engelmann & Carnine, 1982; Guthrie, Perencevich, et al. 2004; Hirsch, 2006; Kearsley, 2008; Kintsch, 2004; Klentschy, 2003; Kolodner et al. 1993; Luger, 2008; McNamara et al. 2007; McNamara & Kintsch, 1996; Novak & Canas, 2006; Palincsar et al., 2007; Pearson et al. 2010; Pashler et al. 2009; Romance & Vitale, 2010; Schank, 1996; Schmidt et al. 2001; Shanahan, 2010; Sidman et al. 2007; Sowa, 2000; Walsh, 2003; Weaver & Kintsch, 1995

Interdisciplinary Principles Incorporated as Science IDEAS Model Attributes

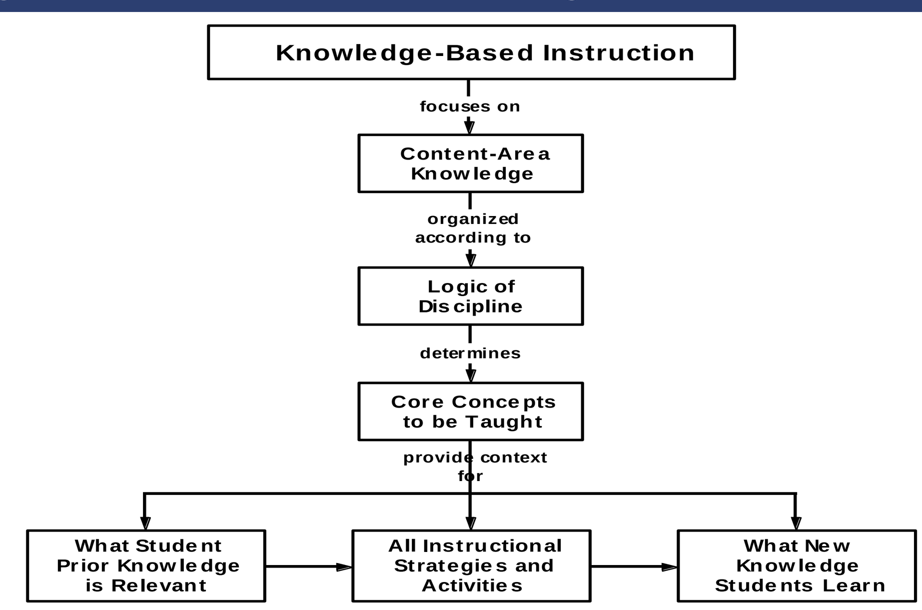
1. Using the *logical structure of concepts in the discipline* as the basis for a grade-articulated curricular framework.
2. Insuring that the *curricular framework provides students with a firm prior knowledge foundation* essential for maximizing comprehension of "new" content to be taught.
3. *Focusing instruction on core disciplinary concepts* (and concept relationships) and explicitly addressing prior knowledge and cumulative review.
4. *Providing adequate amounts of initial and follow-up instructional time necessary to achieve cumulative conceptual understanding* emphasizing "students learning more about what they are learning".
5. Guiding *meaningful student conceptual organization of knowledge* by linking different types of instructional activities (e.g., hands-on science, reading comprehension, propositional concept mapping, journaling/writing, applications) to those concepts.
6. Providing 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).
7. Referencing 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 that occur in terms of science concepts).
8. Incorporating the use of in-depth, meaningful, *cumulative learning within the content-oriented discipline of science as a necessary foundation for developing student proficiency in reading comprehension* and written communication.

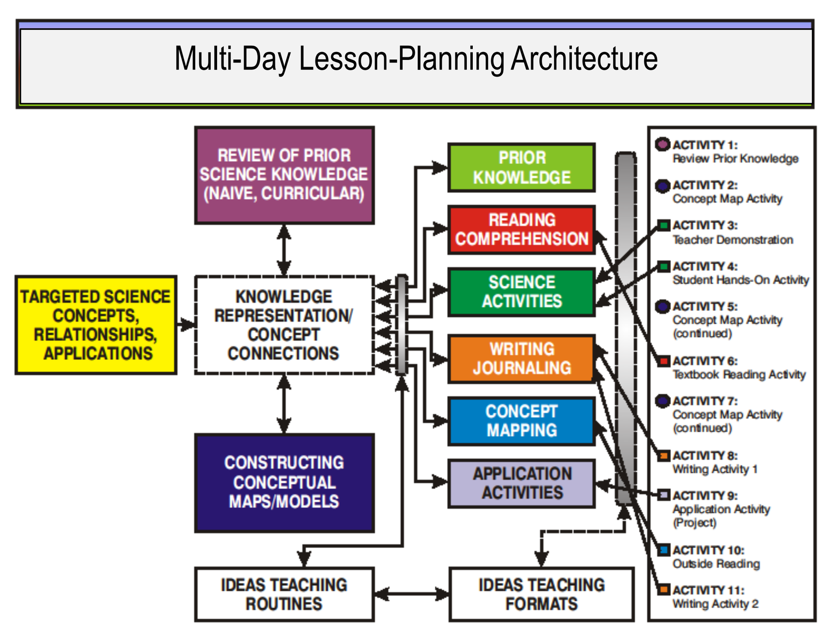
Science IDEAS Instructional Elements

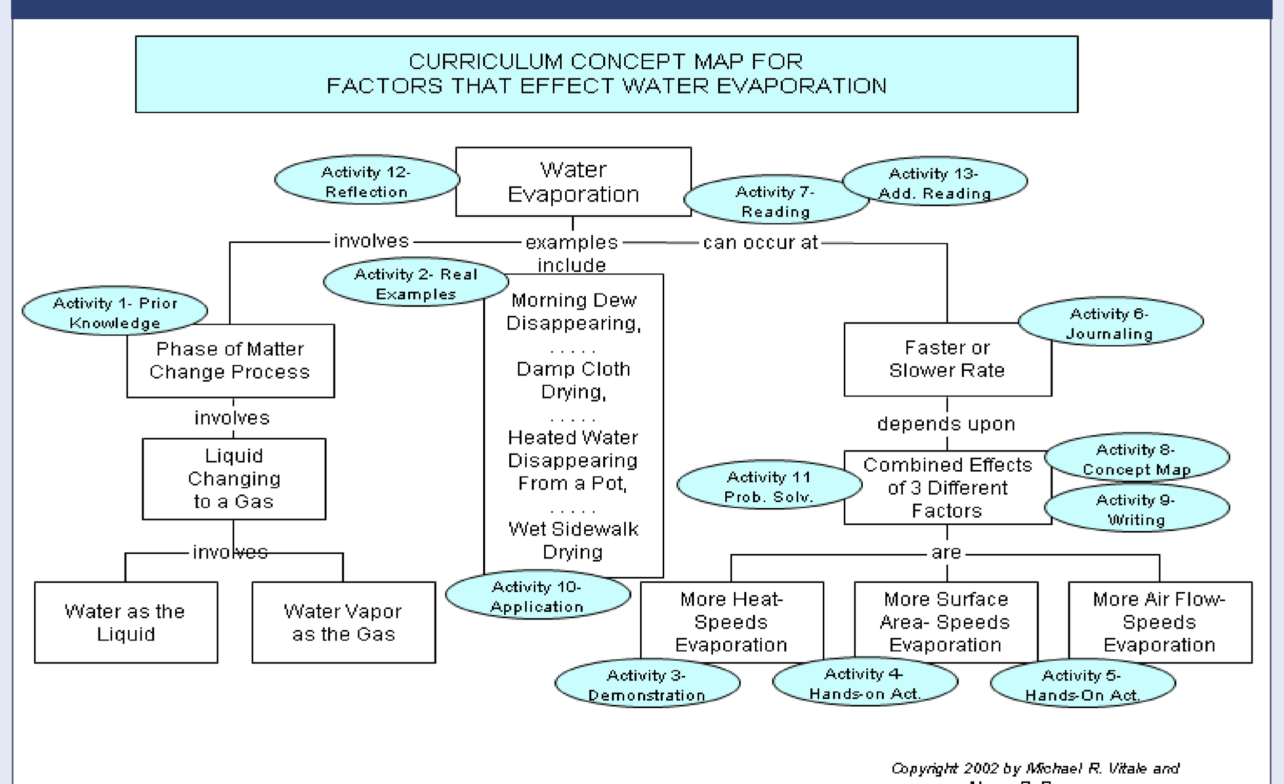
- ***Science Investigation:*** Use of hands-on activities with guided/open-ended inquiry, concept verification
- ***Reading Comprehension***: Specific strategy for guiding student reading of informational text to enhance deep understanding
- ***Propositional Concept Mapping***: Strategy for visual organization and representation of knowledge in coherent fashion
- ***Journaling and Writing***: Guiding students to record their cumulative understanding/thinking and questions as a basis for review/writing
- ***Application Activities / Projects***: Activities for application of concepts across varied contexts
- ***Prior Knowledge / Cumulative Review***: Instructional strategies for accessing prior curricular knowledge and for scheduling curricular review

Planning Science IDEAS Multi-Day Lessons

Knowledge-Based Instruction, Lesson-Planning Architecture, A Multi-Day Lesson







Research Methods and Data Sources

All studies in the series followed a similar research methodology: (a) participants (teachers in earlier studies, schools in later work) were recruited by the researchers, and (b) demographically-similar classrooms or schools served as controls. All research was done in two large urban school districts in southeastern Florida having highly diverse (e.g., approximately 65% minority) student populations.

Science IDEAS Multi-Year Research Findings: 1992- Present

Year(s)	Grade(s)	Duration	Participants	Significant Effects of the Science IDEAS Intervention on Student Achievement
Early Studies in Grades 4, 5				
1992 [a]	4	1 year	3 classes	Initial Science IDEAS study: +.93 GE difference on MAT Science, and +.33 GE difference on ITBS Reading
1993 [b]	4	1 year	3 classes	Replication: +1.5 GE difference on MAT Science, and +.41 GE difference on ITBS Reading
1996 [b]	4-5	5 months	15 classes	Primarily at-risk students: Grade 5- +2.3 GE mean difference on MAT Science, and +.51 GE difference on ITBS Reading. Note- Grade 4 effects were not significant in this 5-month study
1998 [b]	4-5	1 year	45 classes	Regular and at-risk students: + 1.11 GE difference on MAT science, and +.37 GE difference on ITBS Reading
Longitudinal Study: Direct Effects in Grades 3, 4, 5 and Indirect/Transfer Effects to Grades 6, 7, 8				
2002-2007 [c]	3-5	multi-year	6 schools	Schoolwide implementations in grades 3-5, cross-sectional longitudinal study with transfer effects assessed in grades 6-8: +.38 GE difference on ITBS Science, and +.32 GE difference on ITBS Reading across grades 3-8, with the differences in grades 6-8 demonstrating consistent transfer effects from grade 3-5 on both science and reading.
2003-2008 [d]	3-5	multi-year	6 schools	Replication study paralleling preceding 2002-2007 findings. Schoolwide implementations in grades 3-5, cross-sectional longitudinal study with transfer effects assessed in grades 6-7: +1.30 GE differences on ITBS Science. and +.71 GE differences in ITBS Reading across grades 3-7, with the differences in grades 6-7 demonstrating consistent transfer effects from grade 3-5 on both science and reading.
Studies in Primary Classrooms (K, 1, and 2)				
2005 [e]	1-2	8 weeks	2 schools	Schoolwide implementation (Note- K and grade 1 students were tested at the beginning of their following year in grades 1 and 2 respectively): Grades 1-2 Overall: +.42 GE difference in ITBS Science. Grade 2: +.72 GE difference in ITBS Reading. Note- Grade 1 effect was not significant on ITBS Reading.
2007 [f]	1-2	1 year	2 schools	Schoolwide implementation: +.16 GE difference on ITBS Science, and +.58 GE on ITBS Reading
2014 [g]	1-2	6 Months	9 schools	Schoolwide implementation: +.52 GE difference on ITBS Science, and +.26 GE difference on ITBS Reading

Note 1. All analyses findings presented are statistically-adjusted mean differences between Science IDEAS and Control students. For purposes of interpretation, the adjusted mean differences in the Table show the improvement in academic achievement for science or reading that resulted from participation in the Science IDEAS instructional model. For consistency in later studies, non-standardized HLM coefficients (coded as 1 = Experimental, 0 = Controls) as adjusted means were reported rather than OLS adjusted means.

Note 2. Publication/paper references for each study are (a) Romance & Vitale (1992), (b) Romance & Vitale (2001), (c) Vitale & Romance (2009), (d) Vitale & Romance (2011b), (e) Vitale & Romance (2011a), (f) Vitale & Romance (2012), and (g) Romance, Vitale, & Palincsar (2015)

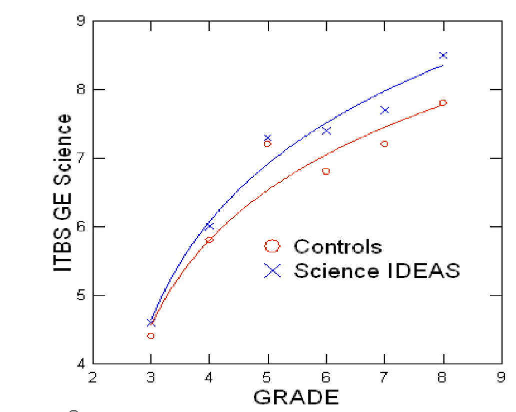
Implications: Changing K-5 Curricular Policy to Increase Time for Science Instruction

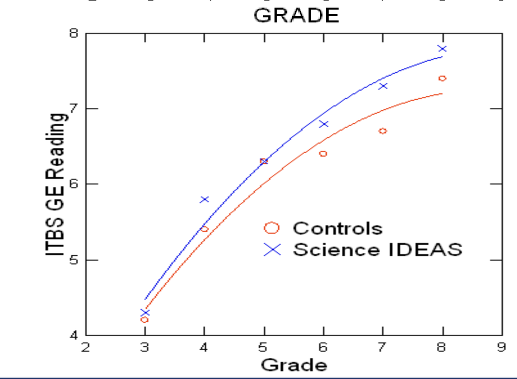
The pattern of findings provides consistent evidence that the interdisciplinary-oriented Science IDEAS model for integrating reading/language arts within time-expanded, in-depth science in grades 1-5 is feasible and effective in accelerating both student science achievement and reading comprehension proficiency. An important complementary finding is that these grade 3-5 achievement effects also transfer to grades 6-8.

The implications from these studies and related work (see Pearson et al., 2010) conflict substantially with the lack of emphasis on meaningful curricular content associated with the present approaches to reading/language arts that dominate K-5 schools (e.g., Hirsch, 1996, 2006; Walsh, 2003). With an accountability emphasis to improve reading outcomes, present approaches have resulted in a significant decrease in or elimination of science instruction (Dillon, 2006; Jones et al., 1999). In contrast, following the present pattern of interdisciplinary research, increasing the instructional time allocated to science instruction across grades K-5 promises a curricular solution to what has been the continuing systemic problem of reading comprehension within school reform.

Direct (Grade 3-5) and Transfer Effects (Grades 6-8) of Science IDEAS Model

Science and Reading: 2002-2007





Science IDEAS Teachers and Students

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