An Interdisciplinary Model for Accelerating Student Achievement in Science and Reading Comprehension Across Grades 3-8: Implications for Research and Practice

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Abstract

Evaluative analyses of present educational reform initiatives have evidenced little if any success toward their goal of engendering successful academic performance in science and reading comprehension at the secondary level. This paper presents the direct effects in grades 3-5 and associated transfer effects in grades 6-8 on student achievement in science and reading of a cognitive-science-based instructional model (Science IDEAS) in which reading/language arts is integrated within in-depth science instruction. Implications of the findings for changing K-5 curricular policy to increase the instructional time for science instruction are discussed in conjunction with complementary changes in school accountability methodology that would interpret performance by elementary students on state tests in terms of projected academic success at the high school level and allow schools to be evaluated in terms of the achievement of students enrolled on a continuing basis across grades K-5.

Despite a twenty-year emphasis on educational reform, student achievement in science and reading comprehension as reported in numerous international (Schmidt et al, 1999, 2001; Stephens & Coleman, 2007) and national reports (NAEP) in science (Grigg et al., 2006; Lutkus et al., 2006; USDOE 2001, 2005) and reading (NCES, 2009) remain systemic problems. In particular, meaningful content area learning from text has continued to be a significant barrier to both science learning and reading comprehension (e.g., AFT, 1997; Donahue et al., 1999; Feldman, 2000; Snow et al., 2002) for low socioeconomic status (SES) students who depend on school to learn (see Gamse et al., 2008; Kemple, et al., 2008; James-Burdumy et al., 2006; NCES, 2009). When reaching high school, many students from all SES strata have neither the sufficient conceptual prior knowledge to perform successfully in secondary science courses nor the more general capacity for building the coherent mental representations necessary for text comprehension (van den Broek, 2010).

Within the present reform framework, the lack of instructional time devoted to in-depth science teaching in elementary schools (see Dillon, 2006; Jones et al., 1999; Klentschy & Molina-De La Torre, 2004) has been identified as a key issue necessary to reform science (Hirsch, 1996; Vitale, Romance, & Klentschy, 2006) and, in a related sense, reading comprehension (Chall, 1985; Guthrie & Ozgungor, 2002; Pearson et al, 2010; van den Broek, 2010). Currently, there are few opportunities for elementary students to engage in the form of content-area reading that enables them to cross borders between everyday language and the discourse of science (Klentschy & Molina-De La Torre, 2004; Norris & Phillips, 2003; Romance & Vitale, 2010; Webb, 2010). Even with strong advocacy from reading researchers (Chall, 2003;

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Duke, 2010; Guthrie et al., 2002; Pearson et al., 2010; Snow, 2002) to integrate literacy with science, little effort to increase time for 'reading to learn' has occurred. In effect, there is sufficient evidence to suggest that the United States is neither providing the general population with the levels of scientific literacy (Krajcik & Sutherland, 2010) necessary to support learning of complex science concepts (van den Broek, 2010) nor the level of reading comprehension proficiency necessary for being successful in the workplace and acting as informed citizens (see Duschl et al., 2007; NAEP 2003, 2005).

Consensus Interdisciplinary Perspectives on School Learning

Meaningful learning in science. Current interdisciplinary research related to meaningful learning summarized by Bransford et al. (2000) provides a foundation as to how conceptual understanding in content domains such as science establishes the prior knowledge and knowledge-structures necessary to support future learning as a core element in literacy development (e.g., reading comprehension as a form of understanding, coherent writing). Bransford et al summarized research studies of experts and expertise as a unifying concept for meaningful learning. Because the disciplinary structure of science knowledge is highly coherent, cumulative in-depth instruction in science provides a learning environment well-suited for the development of such understanding. As such, coherent curricular structures (e.g., Duschl et al., 2007; Lehrer et al., 2004; Smith et al., 2004, 2006) can readily incorporate elements associated with the cumulative development of curricular expertise by students. In turn, with the active development of such in-depth conceptual understanding serving as a curricular foundation (e.g., Carnine, 1991; Glaser, 1984; Kintsch, 1998; Vitale & Romance, 2000), the use of existing knowledge in the acquisition and communication of new knowledge provides the basis for engendering meaningful learning outcomes in science as well as scientific literacy and content-area reading comprehension.

Comprehension and Learning. Comprehension of printed materials (e.g., texts, science trade books, leveled readers) requires students to link relevant background knowledge to their construction of a coherent mental representation that reflects the intended meaning of the text (van den Broek, 2010). In effect, learner background knowledge supports the interpretation of text material. If learner background knowledge is highly organized around core concepts and concept relationships, there is a greater likelihood that the knowledge can be accessed for gaining new knowledge and understanding as well as serve as the basis for interpreting authentic experiences presented within science instruction. And, because the disciplinary structure of science knowledge is highly cohesive, cumulative in-depth instruction in science provides a learning environment well-suited for the development of understanding as expertise.

As a focus for meaningful learning in school settings, science conceptual knowledge is grounded on the everyday events students experience on a continuing basis. In developing science knowledge, elementary students are able to (a) link together different events they observe, (b) make predictions about the occurrence of events (or manipulate conditions to produce outcomes), and (c) make meaningful interpretations of events that occur, all of which are key elements of meaningful comprehension (see Vitale & Romance, 2007). In turn, with the active development of such in-depth conceptual understanding in science serving as a foundation, the use of prior knowledge in the comprehension of new learning tasks and in the communication of what knowledge has been learned provides a basis for key aspects of literacy development.

Representative research integrating reading and science in grades K-3. At the K-3 level, researchers (Conezio & French, 2002; French, 2004; Smith, 2001) reported the feasibility of curricular approaches in which science experiences provide rich learning contexts for early childhood curriculum resulting in science learning and early literacy development. Related work has been reported by a variety of science and literacy researchers (e.g., Asoko, 2002; Duke, 2010; Gelman & Brenneman, 2004; Ginsberg & Golbeck, 2004; Newton, 2001; Rakow & Bell, 1998; Revelle et al., 2002; Sandall, 2003; Schmidt et al., 2001; Smith, 2001).

Representative research integrating reading and science in grades 3-5. The potential promise of building student background knowledge for cumulative learning within science as a means for enhancing reading comprehension has been established repeatedly by the work of Guthrie and his colleagues (e.g., Guthrie et al., 2004; Guthrie & Ozgundor, 2002) with upper elementary students. In her analysis of basal reading series, Walsh (2003) noted that their use represented a lost opportunity to build the background knowledge necessary for comprehension. Other researchers (Armbruster & Osborn, 2001; Beane, 1995; Ellis, 2001; Hirsch, 1996, 2001; Palincsar & Magnusson, 2001; Pearson et al., 2010; Romance & Vitale, 2010; Schug & Cross, 1998; van den Broek, 2010; Yore, 2000) also have presented findings that support interventions in which core curriculum content in science serves as a powerful framework for building background knowledge and greater proficiency in the use of reading comprehension strategies. Research findings associated with the *Science IDEAS* model (described below) have repeatedly demonstrated that replacing traditional reading/language arts time with in-depth science instruction within which reading comprehension and writing are embedded consistently results in higher achievement outcomes in both reading comprehension and science on norm-referenced tests (Romance & Vitale, 1992, 2001, 2006, 2008b, 2010).

The Science IDEAS Instructional Model: Integrating Reading Within Science

Overview of the Science IDEAS model. Science IDEAS is a cognitive-science-oriented model that integrates reading and writing within in-depth science instruction. In grades 3-5, Science IDEAS is implemented schoolwide in 1.5 to 2 hour daily instructional lessons which focuses on science concepts. Implementation of the model emphasizes students learning more about what is being learned in a cumulative fashion that builds upon core science concepts and concept relationships. The architecture of the model (see Figure 1 for an illustration) involves sequencing different types of classroom instructional activities (e.g., hands-on activities, reading, concept-mapping, journaling/writing) according to a conceptually-coherent curricular framework that follows recommendations in the literature (e.g., Donovan et al., 2003; Duschl et al., 2007; Romance & Vitale, 2001, 2009; Vitale & Romance, 2010).

By cumulatively linking all learning experiences together, students are afforded multiple opportunities to engage in fundamental literacy practices such as discussion, reading, writing and developing forms of argumentation based on their inquiry/explorations and learning from both text-based and non-text-based instructional activities. Implementation of the Science IDEAS model (see Figure 1) involves teacher construction of propositional concept maps representing the conceptual structure of the science concepts to be taught. In turn, these representations insure a coherent conceptual framework for identifying, organizing, and sequencing all instructional activities to be used. This framework also provides a framework for embedded classroom assessment (e.g., Pellegrino et al., 2001; Romance & Vitale, 2001; Vitale, Romance, & Dolan, 2006). As a result, teachers are able to adopt an inquiry-oriented style that emphasizes the cumulative knowledge students have gained over a sequence of different activities (e.g., hands-on, journals/notebooks, concept maps, reading multiple sources, review and application tasks). Within this process, additional knowledge and understanding gained by students always emphasizes learning more about what has been learned so that new learning can be encompassed as much as possible as elaborations of the core concepts taught. Finally, because of the implementation requirements (see following), students who remain enrolled in participating schools experience multiple years of cumulative, in-depth science instruction.

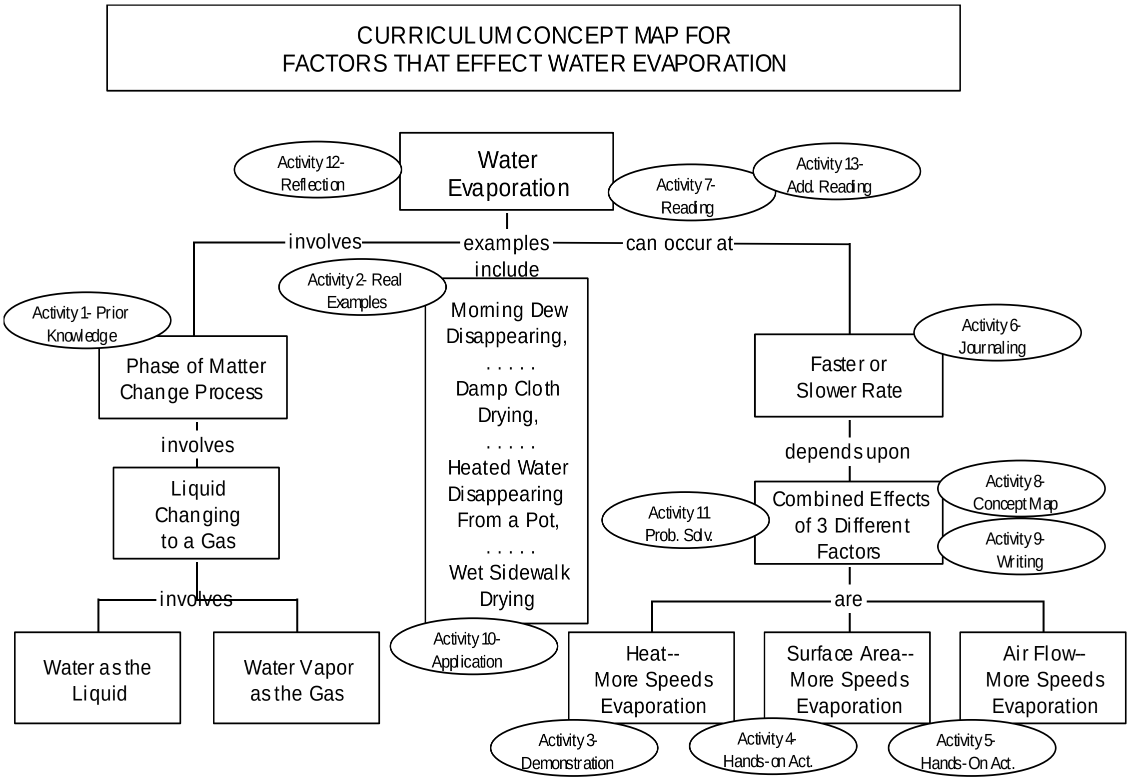

Figure 1. Simplified illustration of a propositional curriculum concept map used as a guide by grade 4 *Science IDEAS* teachers to plan a sequence of instructional activities to form a multi-day lesson. See Appendix A for additional details. .

Schoolwide requirements for the Science IDEAS model . The key implementation requirements for Science IDEAS focus on (a) adopting a schoolwide commitment (all teachers, grades 3-5 and/or K-2) to implement regularly-scheduled, daily use of the model throughout the school year, (b) following a coherent curricular framework adapted from District guidelines incorporating the six Science IDEAS elements (see following section) that emphasize the integration of reading and writing within science instruction, (c) engaging in collaborative teacher grade-level planning that results in the development of classroom multi-day lesson sequences, (d) insuring the participation of all teachers in the sequence of model-oriented professional development opportunities throughout the school year and in the summer, (e) developing a capacity for leadership by school administrators and by school-based teacher leadership cadres, (f) monitoring of classroom fidelity of implementation, and (g) participating in model-focused evaluative activities. As a group, these schoolwide requirements align with attributes of effective reform-based science instructional models (Banilower, et al, 2006; Geier et al, 2008).

In monitoring teacher fidelity of implementation, several complementary approaches are used, including school/classroom visitations by project staff, teacher reflective surveys of fidelity status/issues, principal clinical judgment, and informal input from teacher leadership members. Summary reports of clinical findings are shared twice annually with principals and annually with central school administrators.

Implementing the Science IDEAS elements for integrating science and reading. The Science IDEAS model includes a set of six complementary instructional elements (e.g., hands-on experiments, reading comprehension, propositional concept mapping, journaling/writing, application activities, projects, prior knowledge/cumulative review) that teachers sequence across concept-focused, multi-day lessons to support student conceptual understanding of the science concepts being taught. In determining how to sequence instruction using the six elements, teachers consider three important facets that directly impact learning: (a) the conceptually-organized and sequenced set of concepts and relationships to be taught, (b) where students are positioned within the curricular sequence, and (c) student levels of prerequisite knowledge needed to support learning of the science concepts. In general, all instruction is preceded by teacher assessment of relevant student prior knowledge and/or cumulative review. Using the evaporation concept map shown in Figure 1, Appendix A illustrates one possible way the overall Science IDEAS architecture can incorporate different instructional elements within a multi-day lesson sequence. However, at the same time, consistent with the propositional concept map framework, a wide variety of different specific activities could have been used to engender meaningful learning of both science knowledge and literacy skills.

Purpose of Study

The purpose of this cross-sectional study was to investigate the effects of a multi-year implementation of the Science IDEAS model on (a) the ITBS achievement growth in Reading Comprehension and Science of grade 3-5 students receiving the model, and (b) the transfer effects of the model as measured by ITBS Reading Comprehension and Science to grades 6-8. In doing so, a major objective of the study was to provide implications for school reform that would increase the instructional time for in-depth science instruction as a means for accelerating student achievement in both reading and science.

Method

Setting. The study was conducted in a large (185,000 students), diverse (African American: 29%, Hispanic: 19%, Other: 5%, Free Lunch: 40%) urban school system in southeastern Florida.

Participants. The study intervention (Science IDEAS) was implemented schoolwide in grades 3-5 in 12 elementary schools representative of the student diversity of the school system. Students in 12 demographically-similar schools served as controls. In addition, former Science IDEAS grade 6-8 students and comparison students in feeder middle schools were tested to assess transfer effects of the intervention.

Intervention. The Science IDEAS model (described previously) implemented in grades 3-5 served as the experimental intervention. The Science IDEAS model integrated reading and writing within in-depth science instruction across daily 1.5 to 2 hours instructional lessons which focused on science concepts. In addition to Science IDEAS instruction, students in participating schools also received a separate ½ hour of daily instruction in literature. The comparison students received the district-adopted basal reading/language arts program as well as an additional ½ hour daily instruction using the district-adopted science curriculum.

Instruments. The nationally-normed *Iowa Tests of Basic Skills (ITBS) Reading Comprehension* and *Science* subtests served as measures of student learning. These were administered at the end of the school year by grade 3-5 teachers in Science IDEAS and control elementary schools and by grade 6-8 science teachers in middle schools falling having feeder pattern relationships with Science IDEAS and control elementary schools (to assess transfer effects of the grade 3-5 model). Fidelity of implementation was monitored by researchers (and principals) on a regular basis throughout the school year.

Research design, data collection and analysis. The study was implemented over a 6-year period. In data preparation, middle school students were linked back to their grade 5 elementary school, in effect, creating virtual grade 3-8 elementary school for data analysis. The overall cross-sectional design was a 2 x 2 factorial (Treatment, Grade), with two outcome measures (ITBS Reading, ITBS Science). Student demographic characteristics (Minority vs. non-Minority status, Gender, and Title 1 eligibility) functioned as student covariates. Separate analyses were conducted for each outcome measure using HLM Version 6.08 (Raudenbush & Byrk, 2002) with students designated as level 1 and teachers as level 2. Treatment and grade were coded with teachers at level 2. In addition, individual degree-of-freedom design variables were used to test for a quadratic grade effect and for treatment x grade interaction components at Level 2.

Results

Clinical assessment of implementation fidelity. Monitoring of implementation fidelity showed that between 86-93 percent of grade 3-5 Science IDEAS teachers implemented the model effectively (with fidelity).

ITBS student achievement outcomes. Tables 1 and 2 summarize the HLM analysis results. As Tables 1 and 2 show, the same pattern of significant findings was obtained for both ITBS Reading and Science. For both achievement measures, the Science IDEAS model resulted in higher achievement (+.40 GE for reading, +.29 GE for science); with grade level and non-minority status both being positively related to achievement; and with eligibility for Title 1 and Male (vs. Female) being negatively correlated with achievement. Because the quadratic grade effect and the treatment x grade interaction components were significant, they were deleted from the final model and not included in the tables. In addition, no cross-level interactions of treatment with the three covariates (Title 1, minority status, male (vs. female) were found. Because student achievement prior to grade 3 was not available, Title 1 status which is typically related closely to student achievement was considered a substitute in interpreting the analysis results.

Discussion

The findings of this multi-year, cross-sectional study substantially extend previously reported research demonstrating the effectiveness of content-area learning in science as a means for improving student reading comprehension. In doing so, this study is suggestive of reversing current curricular policy that emphasizes the major allocation of student instructional time to non-content-oriented basal reading programs in place of meaningful content-area instruction. Implications of the present study are that a curricular approach integrating literacy within in-depth science instruction potentially has the dual benefit of directly and, on a transfer basis, increasing student academic achievement in these two critical areas.

Table 1. HLM Analysis of Intervention by Grade level for ITBS GE Reading Comprehension

Fixed Effect	Coefficient	Standard Error	T-ratio	Approx. d.f.	P-value
For INTRCPT1, B0					
INTRCPT2, G00	2.56	0.24	10.90	347	0.000
GRADE, G01	0.69	0.05	14.57	347	0.000
TRT-C0E1, G02	0.40	0.14	2.97	347	0.004
For TITLE1_1 slope, B1					
INTRCPT2, G10	-0.51	0.09	-5.70	3857	0.000
For NON-MINORITY slope, B2					
INTRCPT2, G20	0.62	0.09	6.90	3857	0.000
For SEXM1_F0 slope, B3					
INTRCPT2, G30	-0.33	0.07	-5.10	3857	0.000

Final estimation of variance components:

Random Effect		Standard Deviation	Variance Component	df	Chi-square	P-value
INTRCPT1,	U0	1.05	1.12	347	1339.90	0.000
level-1,	R	2.07	4.28			

Table 2. HLM Analysis of Intervention by Grade level for ITBS GE Science

Fixed Effect	Coefficient	Standard Error	T-ratio	Approx. d.f.	P-value
For INTRCPT1, B0					
INTRCPT2, G00	1.80	0.18	9.95	320	0.000
GRADE, G01	0.59	0.04	15.55	320	0.000
TRT-C0E1, G02	0.29	0.11	2.68	320	0.008
For TITLE1_1 slope, B1					
INTRCPT2, G10	-0.42	0.06	-6.98	3417	0.000
For NON-MINORITY slope, B2					
INTRCPT2, G20	0.48	0.06	7.50	3417	0.000
For SEXM1_F0 slope, B3					
INTRCPT2, G30	-0.11	0.05	-2.06	3417	0.040

Final estimation of variance components:

Random Effect		Standard Deviation	Variance Component	df	Chi-square	P-value
INTRCPT1,	U0	0.79	0.63	320	1357.29	0.000
level-1,	R	1.46	2.15			

The specific rationale underlying the argument for increased time for science instruction is twofold. First, increased time for science instruction in grades K-5 would provide a foundation which middle school teachers could use to better prepare students in grades 6-8 for success in subsequent science courses in high school. And, second, increasing instructional time for K-5 science also would serve as a means for advancing student achievement in reading comprehension across the K-8 grade range. Lack of success on this reading objective reading has been a major failure of present K-5 educational reform models that allocate increased instructional time for reading instruction by reducing time for science and other content-areas. In fact, the lack of content-area instruction and content-area reading in grades K-5 may well be a major reason for the failure of educational reform in U.S. schools (see Hirsch, 1996; Walsh, 2003, Snow, 2002).

In providing an accountability framework consistent with the rationale for increasing time for science, a number of facets can be identified (Romance & Vitale, 2008a). First, all student achievement outcomes in grades 3-8 should be interpreted in terms of projected levels of achievement expected in beginning high school (e.g., grade 9 test achievement, grade 9 course mastery). Without such a perspective, schools can continue to interpret (or over-interpret) student achievement in elementary school grades only in terms of state or national grade-focused norms that are misleading with regard to future success at the secondary levels for large numbers of students (e.g., recent NAEP findings).

Second, the structure of K-5 school accountability models should be refined to distinguish the cumulative effect of schools on students continuously enrolled from those who have attended fewer years (e.g., one or two) or who have attended less than a full school year. Establishing the effectiveness of schools in terms of the students continuously enrolled is, in fact, the most direct and valid measure of the instructional effect of a K-5 school and, as a logical extension, of the cumulative impact of a K-5 in-depth science initiative such as Science IDEAS on student achievement growth.

In general, Science IDEAS is an exemplar of an instructional model that incorporates consensus findings from a variety of research literatures that emphasize the importance of developing cumulative conceptual understanding of science in an age-appropriate fashion in grades K-5. Rather than reducing instructional time for science, an evidence-based approach that promises to advance educational reform would be for schools to replace or extensively complement traditional reading/language arts instruction with in-depth science instruction in which literacy development is integrated.

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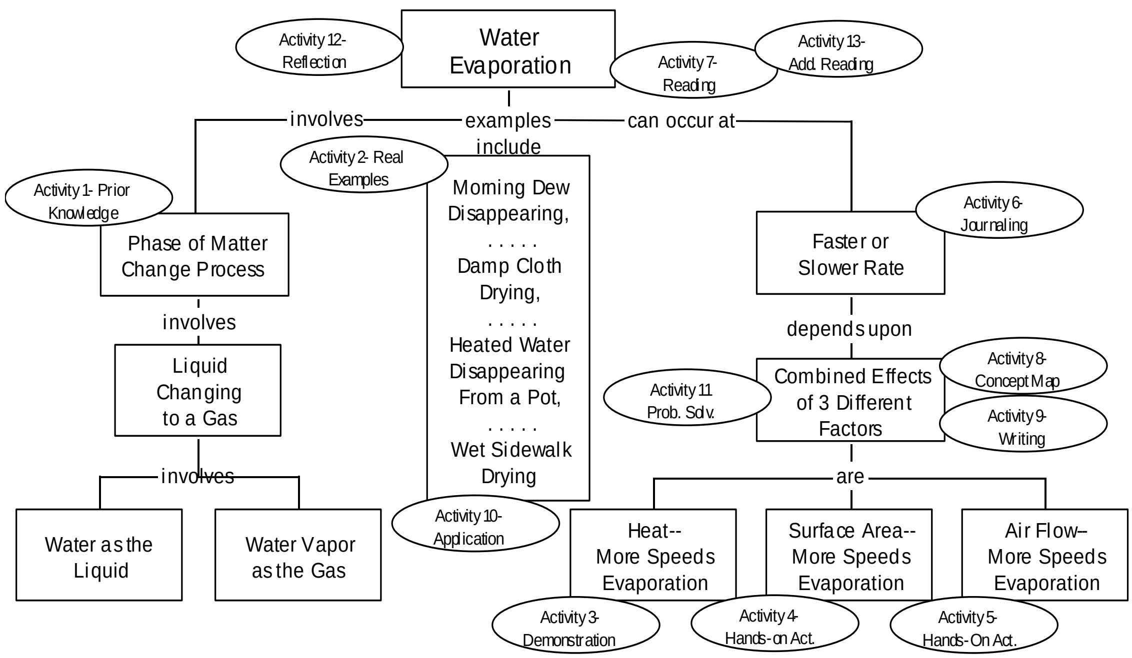
Appendix A

Illustrated in this Appendix is how a Science IDEAS multi-day lesson is organized and how different Science IDEAS elements (e.g., hands-on activities, reading comprehension, writing/journaling, propositional concept mapping, prior knowledge review) would be used as instructional activities. In the model, teachers engage in collaborative lesson planning to identify specific activities that address the concepts to be learned. In the following example, the Evaporation Concept Map is used as a framework for organizing activities for a multi-day Science IDEAS lesson. (Note- in State Benchmarks, SC = Science, LA = Language Arts)

CURRICULUM CONCEPT MAP FOR
FACTORS THAT EFFECT WATER EVAPORATION



Activity 1- Focus is upon reviewing prior curriculum knowledge about phases of matter. Teacher asks students to present examples of solids, liquids, and gases. Teacher selects several examples and asks what they would observe if they were to change phase (e.g. solid to liquid, liquid to gas, gas to liquid, liquid to solid).
<u>State Benchmarks Addressed</u>:
SC.A.1.2.2 (Knows change of state.)
SC.A.2.2.1 (Knows particles are too small to see.)
LA.5.3.1.1 (Uses prior knowledge.)

Activity 2 – Focus is upon accessing real world examples involving evaporation. Teacher presents students with a variety of scenarios involving evaporation (e.g. water droplets on car in morning, puddle of water on concrete sidewalk, boiling water in a pot, damp cloth in air) and asks students to explain what happens (i.e. water as liquid changes into gas). Teacher records key words students offer (e.g. liquid, gas, water, steam, water vapor, boiling, heat, air, temperature) on a chart tablet (incomplete list for future reference). Teacher uses the word "evaporation" to represent the process all scenarios have in common (i.e. in all cases, water changed into gas, water vapor that goes into air).

State Benchmarks Addressed:
SC.A.1.2.2 (Knows change of state.)
SC.B.1.2.2 (Knows heat is a form of energy)
SC.H.2.2.1 (Natural events are predictable.)
LA.5.3.1.1 (Uses prior knowledge.)

Activity 3 – Focus is upon a teacher demonstration showing how heat serves as a factor that speeds the process of evaporation. Teacher uses two equally damp paper towels, placing one near a heat source and the other nearby but away from the heat. Students observe that heated towel dries quicker and discuss the role of heat as a process that speeds evaporation. Teacher repeats demonstration with two different heat sources applied to damp towels followed by discussion. Teacher refers students back to evaporation scenarios (Activity 2) and asks students to point out possible role of heat.

State Benchmarks Addressed:
SC.B.1.2.2 (Knows heat is a form of energy)
SC.H.1.2.2 (Knows method to observe, record, analyze, and communicate.)
SC.H.1.2.4 (Knows to compare and contrast)
LA.5.3.1.1 (Uses prior knowledge.)

Activity 4 – Focus is upon students exploring how surface area serves as a factor that speeds evaporation. Students use two equally damp paper towels, one crumpled into a ball and one spread out, and observe which dries more quickly. Students discuss findings. Teacher refers students back to evaporation scenarios (Activity 2) and asks students to point out possible role of surface area.

State Benchmarks Addressed:
SC.B.1.2.2 (Knows heat is a form of energy)
SC.H.1.2.2 (Knows method to observe, record, analyze, and communicate.)
SC.H.1.2.4 (Knows to compare and contrast)
SC.H.2.2.1 (Natural events are predictable.)

Activity 5 – Focus is upon student exploring how moving air serves as a factor that speeds evaporation. Students use two equally damp paper towels that are spread out. Students fan air over one towel but not the other. Students observe which dries more quickly. Students discuss findings. Teacher refers students back to evaporation scenarios (Activity 2) and asks students to point out possible role of moving air.

State Benchmarks Addressed:
SC.H.1.2.2 (Knows method to observe, record, analyze, and communicate.)
SC.H.1.2.4 (Knows to compare and contrast)
SC.H.2.2.1 (Natural events are predictable.)

LA.5.3.1.1 (Uses prior knowledge.)

Activity 6 – Journal writing activity. For each experiment, students sketch a picture of the experiment and describe what each experiment illustrated with regard to evaporation. For each experiment, students are asked to select one of the evaporation scenarios in Activity 2 and explain how each of the three experiments is relevant to understanding it (i.e. in terms of factors that affect evaporation).
State Benchmarks Addressed:
SC.H.3.2.2 (Knows to collect data to explain an event.)
LA.5.3.1.1 (Uses illustrations to recall facts)
LA.5.4.2.2 (Record information related to a topic, grouping related ideas)
LA.5.2.2.3 (Writes observations that reflect comprehension of content.)
LA.5.4.2.3 (Creates expository responses in an organized pattern)

Activity 7 – Focus is upon a guided reading comprehension activity using a science textbook. Teacher selects passages related to the process of evaporation. Students take turns reading the passages aloud as teacher engages student in a sentence-by-sentence discussion of the passage (including relating the passage to the previous activities). During discussion, students list the key words from the passage in their journals. Teacher gives students comprehension questions. Students re-read the passages independently and answer questions. Teacher guides the review and discussion of each question.
State Benchmarks Addressed:
SC.B.1.2.2 (Knows heat is a form of energy)
LA.5.1.7.3 (Uses headings to anticipate contents.)
LA.5.1.7.8 (Use simple strategies to increase comprehension.)
LA.5.1.7.8 (Rereads, clarifies, group discussion.)
LA.5.1.7.3 (Understands main idea and supporting facts.)

Activity 8 – Focus is upon teacher-guided student concept mapping activity that enables students to link/connect concepts in a conceptually-sound way. Teacher uses the IDEAS concept mapping routine to guide student construction of a group concept map for evaporation and factors that affect evaporation. Teacher has students refer to key words in journal as a reference source for building the concept map.
State Benchmarks Addressed:
SC.A.1.2.2 (Knows change of state.)
SC.B.1.2.2 (Knows heat is a form of energy)
SC.H.3.2.2 (Knows to collect data to explain an event.)
LA.5.1.7.8 (Uses simple strategies to increase comprehension.)
LA.5.2.2.3 (Reads and organizes information.)

Activity 9 – Focus is upon teachers guiding students in using the concept map for expository writing. Teacher guides student use of the concept map constructed in Activity 8 as a blueprint for writing about evaporation and factors that affect evaporation. As the expository assignment unfolds, teachers help students understand how a paragraph

represents a cluster of highly related concepts (as organized within the map). Writing activity is placed in journal or displayed along with student illustrations.
State Benchmarks Addressed:
SC.A.1.2.2 (Knows change of state.)
SC.B.1.2.2 (Knows heat is a form of energy)
SC.H.1.2.2 (Knows method to observe, record, analyze, and communicate.)
LA.5.2.2.3 (Reads and organizes information.)
LA.5.3.1.3 (Prepares for writing by grouping related ideas.)
LA.5 4.2.2 (Writes down information to record.)
LA.5.4.2.3 (Creates expository responses in logical order.)

Activity 10 – Focus is upon extending learning to an out-of-school application context. Students are asked to identify examples of evaporation in their everyday world (e.g. clothes in a dryer, food in a microwave, clothes on a line, hair-dryer, hanging damp towel to dry), how to interpret each in terms of different factors effecting evaporation, and record their examples and interpretations in their journals for discussion in class.
State Benchmarks Addressed:
SC.H.1.2.2 (Knows method to observe, record, analyze, and communicate.)
SC.H.3.2.2 (Knows to collect data to explain an event.)
LA.5.3.1.3 (Prepares for writing by grouping related ideas.)
LA.5 4.2.2 (Writes down information to record.)
LA.5.4.2.3 (Creates expository responses in logical order.)

Activity 11 – Focus is upon engaging students in a problem-solving hands-on activity. Students work in cooperative groups to solve problems related to speed of evaporation: (1) given equally damp paper towels, students compete to design and implement a strategy to dry their towel as quickly as possible within the specified time limit; and (2) given equally damp towels, students compete to design and implement a strategy to keep their towel from drying out as little as possible in a specified time limit. At the end of each activity, student judges determine the winning group and the teacher leads a discussion of the different strategies used in terms of factors that affect evaporation.
State Benchmarks Addressed:
SC.H.1.2.2 (Knows method to observe, record, analyze, and communicate.)
SC.H.1.2.3 (Knows to work collaboratively to justify conclusions.)

Activity 12 – Focus is upon relating new knowledge to a prior knowledge activity. Teacher displays chart with key words from students' original ideas from the prior knowledge activity (Activity 2) and the concept map developed in Activity 8. Teacher guides reflective class discussion on how their knowledge has developed and become more organized.
State Benchmarks Addressed:
SC.H.3.2.2 (Knows to collect data to explain an event.)
LA.5.1.7.8 (Uses simple strategies to increase comprehension.)
LA.5.1.7.8 (Rereads, clarifies, group discussion.)

Activity 13 – Focus is upon having students read more about what they already know. In doing so, the teacher selects additional reading materials from a variety of sources on evaporation and related topics for students to read, summarize in journals, and share with class using the project-developed 30 ways to share a non-fiction book. Students are encouraged to read up to 10 different sources on the topic or related topics (e.g., evaporation within the water cycle).

State Benchmarks Addressed:

SC.H.3.2.4 (Knows through knowledge, people can form new ideas.)
LA.5.1.7.3 (Uses headings to anticipate contents.)
LA.5.1.7.8 (Selects strategies to identify words from graphics, illustrations)
LA.5.1.7.8 (Rereads, clarifies, group discussion.)
LA.5.1.7.5 (Recognizes comparison and contrast in text.)