Direct and Transfer Effects of a Model Integrating Reading and Science in Grades 1-2: Results and Policy Implications [1]

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Abstract

Implemented was a 45 minute per day Primary Science IDEAS intervention integrating reading and writing within science instruction in 7 experimental and 11 control schools. Results found a significant direct achievement effect in grades 1-2 on both ITBS Reading and Science. In addition, the effect of the intervention in grades 1-2 resulted in significant transfer to grade 3 on both ITBS Reading and Science. Discussed are policy implications of the findings for increasing instructional time allocated to science in grades 1-2 and for expanding the focus of grade 1-2 assessment student achievement to include content-area learning.

This study, funded by the National Science Foundation, was designed to increase opportunities for children in grades 1-2 to be engaged in meaningful, inquiry-based science learning that was inextricably linked to conceptually-relevant, content-area reading and writing/journaling as advocated by the recent standards documents within science - Next Generation Science Standards (NGSS, Achieve, 2013) and literacy - Common Core State Standards, (National Governor's Association [NGAC- CCSSO], 2010). Implementation of the integrated Primary Science IDEAS instructional model concurrently addresses key literacy and science standards, provides more authentic learning experiences for students, increases children's understanding of the natural world, builds upon a synergy that deepens understanding, and establishes the background knowledge critical for supporting student reading comprehension development (Cervetti, et. al., 2012; Guthrie & Alao, 1997; Guthrie at al., 2004; National Research Council [NRC], 2014; Varelas, et. al., 2006).

The current research literature provides a framework for understanding how linking science and literacy is not only grounded in a rich and growing evidentiary base that strongly suggests how each discipline synergistically supports the other in terms of learner outcomes (Pearson, et. al., 2010; Palincsar & Magnusson, 2001). Such an approach incorporates cognitive science principles (Bransford, et al., 2000; Kintsch, 1994, 2004; McNamara & Kinstch, 1996; Van den Broek, 2010) indicating the importance of a learning environment in which curricular coherence serves as the basis for organizing science concepts and building student prior knowledge, both of which support reading comprehension and writing as forms of meaningful understanding. Further, linking core science ideas with age-appropriate practices of science (e.g., asking questions, engaging in argument from evidence) aligns with literacy practices (e.g., using evidence to support a claim) that together support student comprehension of progressively more complex science texts in upper elementary and beyond (e.g., Asoko, 2013; ; Author 1 & Author 2, 2001, 2012a, 2017; Author 2 & Author 1, 2012a, 2012b; Brenneman, 2011; Conezio & French, 2002; Dickinson, 2011; Dougherty, 2014; Gelman (NRC, 2005, p. 7); Greenfield, et al., 2009; Morgan et al., 2016).

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Research Questions

1. Would the integration of science and literacy using the Primary Science IDEAS model in grades 1-2 directly increase student achievement in reading comprehension and science as measured by the ITBS?
2. Would the direct results of using the Primary Science IDAS model on student achievement in reading comprehension and science transfer from grades 1-2 to grade 3?

Method

Sample. A total of 7 experimental and 11 demographically-comparable control schools in a large (185,000), diverse (African American: 29%, Hispanic: 28%, White: 37%; Other: 6%, Free Lunch: 40%) school district in Southeastern Florida participated. The intervention was implemented schoolwide in all regular grade 1-2 classrooms. The number of grade 1-2-3 students in experimental and control schools, respectively, was 3,845 and 4,724.

*Instruments***.** The ITBS Science and Reading subtests were administered at the end of the school year to a sample of (N=5) randomly selected grade 1-2 students from all classrooms implementing the intervention in experimental schools and in N=4 randomly selected grade 1 and grade 2 classrooms in control schools with the constraint that selected grade 2 students were enrolled in the same school in grade 1. In addition, (N=5) grade 3 students from N=4 randomly selected classrooms in each experimental and control school were selected randomly with the constraint that they were previously enrolled in the same school the two preceding years (i.e., in grades 1 and 2). The students in grades 1-2 provided measures of the direct effect of the intervention while the grade 3 students provided measures of the transfer effect of the grade 1-2 intervention to grade 3.

Intervention. The intervention implemented in grades 1-2 consisted of an interdisciplinary-oriented instructional model (Primary Science IDEAS) in which reading and writing were integrated within age-appropriate science instruction (See Author 1 & Author 2, 2012a). Following Florida's Next Generation Sunshine State Standards (FL - NGSSS) curriculum standards, students engaged in multi-day lessons focusing on selected core disciplinary science concepts that involved multiple occurrences of six elements focusing on the concept or concepts to be learned: Hands-on exploration activities, Reading multiple sources, Journaling/writing, Propositional concept mapping, Application projects, Prior knowledge/cumulative review. Overall, multi-day instructional lessons emphasized open-ended or guided investigations of relevant science phenomena using the practices of science (e.g., posing questions, using evidence to construct explanations) complemented by the multiple concept-oriented science reading materials (e.g., trade books) along with journaling/writing, and concept mapping activities (see Author 2 and Author 1, 2012).

*Design and Procedure***.** Over the three-year study, both experimental and control schools followed the same District adopted reading and science standards. In grades 1-2, all District students (including controls) received 30 minutes/day of science and 90 minutes/day of required reading instruction. However, for experimental classrooms, 15 minutes of their required reading/language arts time was re-allocated to science to make a total of 45 minutes of science/reading/writing each day.

In the study design, all grade 3 experimental and control students sampled for achievement tests at the end of the year had attended their same school in grades 1 and 2. In a

similar fashion, all grade 2 students sampled had attended their same school in grade 1. All randomly selected students were tested on ITBS Reading and Science Subtest achievement outcomes at the end of the school year. In the year 3 data for grades 1-2-3 reported here, student achievement in ITBS Reading and Science reflected two complementary effects. In grades 1-2, student achievement reflected the direct effects of the intervention implemented in grade 1-2. In grade 3, student achievement reflected the transfer effects of the previous two years in grades 1-2.

Statistical analysis consisted of separate multilevel analyses for each ITBS Subtest using HLM 7 following a 3-level model consisting of level 3- schools, level 2- classrooms, and level 1- students. The treatment condition was assigned to schools (level 3), grade to classrooms (level 2), and the ITBS subtest scores, Title 1 status, and Gender to students (level 1). In the analysis, the cross-level interaction between Treatment and Grade was tested along with the main effects of Treatment and Grade. Title 1 status and Gender served as covariates. Because student ethnicity was closely correlated with Title 1 status, ethnicity was not included in the final analysis model.

Fidelity of implementation in grades 1-2 was monitored at the classroom level by project staff through three observations per year over the three years of the study. For each year of the study, the level of fidelity expressed as a percentage ranged from 91 to 88 percent. Reliability estimated through observations by project staff of the same classrooms ranged from .88 to .94.

In the project, experimental teachers in grades 1-2 received 8 days of professional development (4 days summer, 4-days follow-up during the school year) in years 1 and 2 and 4 days (2 days summer, 2-days follow-up) in year 3. The PD focused on the FL NGSSS science standards and the Primary Science IDEAS Model (e.g., reading, writing journaling, science investigations/practices, concept mapping, application projects, and prior knowledge review) which also included the District literacy standards. Control teachers participated in business-as-usual PD from the District (including reading and science).

Results

Table 1 shows the adjusted mean ITBS achievement for the Experimental and Control groups as a function of grade level (i.e. Grade 1, Grade 2, Grade 3) resulting from the 3-level HLM model used for the analysis.

Results of the HLM analysis for ITBS Reading Comprehension found the Treatment main effect significant ($t(16) = 2.34$, $p = .032$, Hedges g Effect = 1.67). Results of the HLM Analysis for ITBS Science also found the Treatment main effect significant ($t(16) = 2.38$, $p = .030$, Hedges g Effect = 1.34). In addition, the HLM analysis found a significant Treatment x Grade interaction ($t(251) = 2.47$, $p = .014$) for Reading Comprehension. Grade, Title 1 status, and Gender also were significant for both HLM analyses.

Following the HLM findings, Table 1 shows an overall positive effect of Treatment on ITBS Reading Comprehension achievement that was increasingly magnified across grades 1-2-3. Table 1 also shows a consistent positive Treatment effect on ITBS Science achievement.

Discussion

The grade 1-2 intervention which integrated literacy instruction within science in support of building student content knowledge through the use of informational genres (i.e., science trade books, science textbooks, authentic science materials) was linked directly to and in support of

Table 1
Primary Science IDEAS Adjusted Mean Grade Equivalent (GE) Achievement for Experimental and Control Groups on ITBS Reading and Science.

Outcome	Direct Effects Grade 1	Grade 2	Transfer Effects Grade 3
ITBS Reading			
Experimental	1.94	3.21	4.43
Control	1.87	3.01	3.92
E vs. C Difference	+.07	+.20	+.51
ITBS Science			
Experimental	2.22	3.38	4.82
Control	1.91	2.96	4.40
E vs. C Difference	+.31	+.42	+.42

Note: GE Means were computed after adjusting for covariate effects. Number of students tested in experimental schools: Grade 1 = 195, Grade 2 = 215, Grade 3 = 219. Number of students tested in control schools: Grade 1 = 181, Grade 2 = 183, Grade 3 = 188.

science learning and subsequent literacy development. In doing so, the integrated Primary Science IDEAS model provided a curriculum strategy for increasing in instructional time available for science that positively impacted transferable reading comprehension achievement in a manner paralleling that shown in from grades 3-4-5 to grades 6-7 (Romance & Vitale, 2017). Linking science and literacy in a manner that results in positive student achievement outcomes broadens instructional perspectives on how to build children's background knowledge in support of comprehension and inferencing required when reading more complex text within content domains that are encountered by students with increased frequency as they progress from one grade to the next.

From the standpoint of grade 1-2 curriculum policy, the research reported here is suggestive that as school districts become more receptive to increasing time for integrated science and literacy as a means of accelerating student reading comprehension achievement, such districts also will be forced to address policy issues associated with changing the focus of high stakes testing from isolated reading skills to the role of reading comprehension in measures of meaningful learning (see Vitale & Romance, 2007).

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