Panels

Dispelling The Myth: Is There An Effect of Inquiry-Based Science Teaching On Standardized Reading Scores?

Jerry Valadez

Abstract: Responding to the urgency of raising language arts test scores and meeting California API goals (Accountability Performance Index), most Fresno elementary schools have stated as a primary instructional goal the integration of language arts and reading with other content areas. As a result, schools are searching for effective strategies to accomplish this goal and sustain improved student achievement. In one effort to research and validate effective strategies, the Fresno Unified School District, with the support of NSF, established professional development models, assessment systems, and instructional strategies delivered through an inquiry-based science program. Results of a preliminary study indicate that students who received inquiry-based science instruction scored better on SAT-9 norm-referenced tests in reading compared to those students that did not receive inquiry-based science instruction, over a four-year period.

The demand for literacy skills in the U.S. workplace is at an all time high and public schools are attempting to respond by increasing the basic literacy requirements for K-12 students. Despite these efforts reading scores nationally have not improved over the last 30 years as measured by the National Assessment of Educational Progress (NAEP), and the U.S. continues to lag behind most other countries on international assessments in reading. In addition, the relative poor performance of U.S. students in mathematics and science assessments internationally is also believed to be rooted in their poor performance as readers. The weakness is that reading is seldom effectively integrated across the various content areas in schools. Reading comprehension, in particular, has been identified, as critical skill children must possess to succeed in school beyond grade three. Even though texts remain the primary source of instruction for content, reading is seldom integrated into content area instruction.

Teaching science in a way that is understandable and meaningful to students, as it promotes increased literacy, can be developed for students using existing science and language arts curricula and recognized best practice strategies. Evidence has been reported that shows inquiry-related teaching effective in fostering ways of thinking, talking, and writing (Fradd & Lee, 1999; Met, 1994; Rosebery et al., 1990). Inquiry-based science teaching also supports the development of reading skills as students development classification skills, oral communication skills, and positive attitudes toward science (National Research

Council, 2000; Lowery, 1995). What follows is an analysis of the effect of inquiry-based science teaching and learning on reading, comprehension, and literacy skills.

Literacy and Language Development of English Learners

Evidence from research indicates that explicit instruction in both academic language and reading is effective in improving student achievement in literacy. Other studies show that certain practices can improve student achievement in literacy when embedded in the natural context of inquiry-based science instruction (Crandall, 1995). Language minority (English Learner)[1] students frequently do not have access to the same courses as other students and are placed in less demanding academic tracks. Despite the known effect of teacher quality on student achievement, it is not uncommon to find these students taught by teachers that are not trained to work with English Learners and with less experienced science and mathematics teachers (August & Hakuta, 1997).

Student's worldview, influenced by their cultural perspective and understanding of words in a cultural context, determine what is feasible for them in a scientific sense. As a result, English Learner (EL) students often understand science and mathematics concepts in their primary language and may have prior knowledge that is never acknowledged by teachers (Met, 1994). A review of several relevant studies indicates that it is important for culturally and linguistically diverse students to develop skills for interconnecting language and reading skills in order to access science and mathematics knowledge (Casteel & Isom, 1994; Diaz, 1994; Lee, Fradd, & Sutman, 1995; Marino & Hammond, 1998; Warren & Rosebery, 1993). Based on these findings, it is evident that EL students will develop significant vocabulary knowledge and conceptual understanding if they use the English language to solve real problems, therefore learning the language through use of the language. The contextualized use of language in science activities must also be designed to provide students with practice using complex language forms and functions.

Fresno Unified's high English Learner student population (32%) necessitates the understanding of the research cited above. Coupled with the fact that most of the designated II/USP[2] school sites have very high EL student populations (40-73%) this research is critical to understanding the barriers that may limit opportunities to learn science. Science learning and language acquisition for EL students is interdependent. Through the contextualized use of language in science inquiry students develop and practice complex language forms and functions.

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[1]The term English Learner is generally used to emphasize the students' learning rather than their limitations.
[2]Immediate Intervention Under Performing Schools Program

Language Literacy, Academic Language, and FUSD K-12 Science Education Reform

The goal of the Fresno Urban Systemic Program (FSP) is to ensure that all Fresno students succeed through increased student achievement in science using a standards-based program. Concurrently, the California accountability system places an emphasis on the improvement of literacy achievement as measured on the Stanford Achievement Test (Form 9). Efforts to accomplish this through articulated instruction in science and language arts is embedded in TESS (FSP) professional development in the following elements:

- Effective implementation of standards-based best practice instructional strategies,
- Effective implementation of standards-based elementary, middle, and high school science programs,
- Effective use of formative assessment to inform instruction,

- Providing access to rigorous content instruction to English Learners (EL) while they develop language proficiency.

Methodology for embedding effective strategies for teaching literacy through standards-based science teaching includes:

- Academic Language/vocabulary development contextualized within science instruction,
- Use of expository literature and text structure to support the development of conceptual understanding,
- Emphasis on reasoning, reading and writing for meaning,
- Questioning strategies,
- Prior knowledge activation (inference strategies),
- Reflections on hands-on experiences,
- Use of scientific and mathematical language and representation with appropriate accuracy, including numerical tables and equations, and algebraic equations,
- Analyzing formulas, charts, graphs, and diagrams,
- Organizing work, explaining facets of a solution orally and in writing,
- Follow the Problem Solution Writing (problem formulation, problem implementation, and problem conclusion) process to present a clear solution to a scientific and/or mathematical investigation,
- The use of graphic organizers, and
- Working portfolios, student work and performance based assessments

Use Of Exemplary Instructional Material Supporting Literacy Connections

Techniques and practices of sound language arts instruction are enhanced through embedded literacy strategies found in both the Harcourt Science and FOSS curriculums (K-6 science programs used in FUSD). The skills essential for all students to internalize and apply scientific concepts and practices, including academic language knowledge and good reading comprehension, is found to be enhanced by the use of the science content based materials. The frequency and spiraling design in which science academic words are introduced and reinforced throughout the science program enhances the acquisition of academic language. Academic language development is further supported through expository literature, hands-on investigations, embedded assessments, and teacher resource materials provided in each FOSS module.

The TESS Science Program, used as designed, ensures that all FUSD students participate in science instruction that requires them to listen, understand, evaluate, and speak effectively using the appropriate conventions of language to communicate scientific ideas. When engaged in the science program, students will:

- Organize thoughts and information using the writing process: developing drafts, analyzing, revising, and editing work based on the science module experienced,
- Read and analyze the Harcourt and FOSS text material to activate prior knowledge, predict outcomes, construct meaning through guided inquiry, process ideas, and apply knowledge to new situations,
- Develop a schema through the experiential component of the curriculum. The schema allows equitable access to scientific conceptual understanding and increased reading comprehension.

Furthermore, analysis of the SAT-9 reveals that 60% of the text in the test itself is expository text. Standards-based science materials provide the majority of expository text material available for students as part of the core instructional program. Ability to understand expository text structure and the academic language it contains will improve student achievement on the SAT-9 and other norm-

referenced tests.

For a preliminary study of how this worked out, please see his paper in Resources

Home | Keynote | Poster Hall | Panels | Discussants Reflect | Resources | Who's Here | Open Discussion | Info Center