Valle Imperial Project in Science (VIPS)
Four-Year Comparison of Student Achievement Data
1995-1999

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Introduction

As the push for accountability races across the public schools of the United States, educators are increasingly asked to demonstrate the effectiveness of instructional programs in terms of student achievement. California is no exception. There is a limited body of research evidence from which educators can draw information regarding student accomplishment trends in science education. In the 1960's, as a response to the need to strengthen elementary science instruction, the first generation of kit-based science instructional programs emerged. There was limited research conducted on the effectiveness of these programs during the 1960's and 1970's. In fact, most of the research on these programs occurred in the 1980's and 1990's. The research findings related to the use of these first generation programs indicated that there was great value in the use of these programs, especially for females, economically disadvantaged and minority students (Shamansky, Hedges, Woodworth, and George, 1990). In the 1990's, as a response to the standards based movement, a second generation of kit-based materials was introduced for elementary science instruction.

For many years, there has been a belief that kit-based instruction, centered on a constructivist approach, produces greater student achievement in science and possibly other curricular areas when compared to a more traditional textbook approach. Critics of the kit-based approach (and constructivism) claim that the programs do not provide the depth and quality of information students need to succeed in advanced science courses (Schroeder 1999; Woolf 1999). The literature is almost silent to support either argument, especially when second generation kit-based materials are compared to a more traditional textbook approach.

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Valle Imperial Project in Science

The Valle Imperial Project in Science (VIPS) is a NSF funded Local Systemic Initiative serving approximately 22,500 K-6 students and 1100 teachers in 14 school districts in Imperial County, California. Imperial County is in the southeast corner of California along the United States border with Mexico. Imperial Valley is both one of the largest (4597 sq. mi.) and most sparsely populated (130,000) counties in California. Located in the extreme southeast corner of the state, the county lacks any large metropolitan area and residents must travel to San Diego (120+ miles) or Los Angeles (200+ miles) to the nearest urban areas. Geographic isolation is especially acute in the San Pasqual Unified School District located on the Quechan Indian Reservation, as residents from this district travel over 60 miles just to get to El Centro, the county seat.

Many Imperial Valley residents live in extreme poverty, with household incomes declining in real dollars over the last decade. The IRS reported a 1997 mean per capita income of $16,322, the lowest of all California counties. The county's unemployment rates increased from 17.1% in 1991 to 34% in 1998, while statewide unemployment rates remained under 10%. Imperial County ranks highest in poverty of all 58 counties in California.

Of the 22,500 K-6 students in the Imperial Valley, 81% are Hispanic, 5% African-American, 11% Caucasian, 1% Asian and 1% Native American, a majority of historically underserved groups. More than 50% of the students in the county are Limited English Proficient, with 10% children of migrant workers. Nearly all of the county's schools qualify for Title I. County-wide, more than 67% of all students are eligible for free and reduced lunches.

The Valle Imperial Project in Science began in the summer of 1998 as a collaborative partnership between the fourteen Imperial County school districts and San Diego State University, Imperial Valley Campus. It was preceded by three years by a pilot effort on the part of the El Centro Elementary School District, which with 6500 students is the largest district in the county. The pilot program established three pilot schools, a fully functioning materials resource center and developed a cadre of lead teachers. This pilot school effort was the result of the El Centro Elementary School District participating as a member of the National Science Foundation funded Pasadena Center Program at the California Institute of Technology. Direct technical assistance and support was provided by the Pasadena Center to build capacity within the district for future district-wide and countywide expansion of the program.

The instructional program which evolved out of this pilot school effort was based upon five critical elements associated with other successful programs of this genre: 1) high quality curriculum; 2) sustained professional development and support for teachers and school administrators; 3) materials support; 4) community and top level administrative support; and 5) assessment.

The program utilizes a mosaic of second generation, high quality, research based instructional materials in the form of kits or modules drawn from sources such as 1) <u>Science and Technology for Children</u> (STC) developed by the National Science Resources Center (NSRC) at the Smithsonian Institution supported by the National Academy of Sciences; 2) <u>Full Option Science</u>

System (FOSS) developed at the Lawrence Hall of Science, University of California, Berkeley; and 3) Insights created by the Education Development Center in Newton, Massachusetts.

Students are exposed to four modules per year except at the kindergarten level where students are exposed to three modules per year. The modules provide a balance of topics each year drawn from life, physical and earth science domains. Using these units or modules, students are provided with rich opportunities to become directly engaged in science process skill development. Science content is covered in greater depth compared to a superficial traditional textbook approach. Each topic then becomes a vehicle for the construction of important scientific concepts that are both developmentally appropriate and able to capture the natural curiosity of the students. All modules are aligned to the National Science Education Standards.

The teachers are provided with at least 100 hours of professional development designed to deepen their own content understanding and to address pedagogical issues. A major focus of the initial training centers on the developmental storyline of the unit. Teachers are engaged in the content of the module in the same manner as their students. The purpose of the developmental storyline is for teachers to experience and understand that the activities of the unit are connected and lead to big ideas in science. Teachers receive in-classroom professional support from a cadre of resource teachers and ultimately have an opportunity to meet in grade level groups to deconstruct or reflect on their teaching practices. Examination of student work is a major component of the reflective teaching practices portion of these sessions. Advanced topics in content, literacy, language acquisition, and module specific multiple measure assessment strategies are also provided.

Materials support in the form of providing all of the materials needed to teach the module including student notebooks are provided by the materials resource center. There has been a high degree of community and top-level administrative support for both the pilot and subsequent countywide program. During the implementation of this systemic reform effort, no other science reform programs were implemented in Imperial County. There were efforts to improve early literacy and strength mathematics instruction; however, the scope of these efforts was not on the same scale as the Valle Imperial Project in Science professional development program.

The "Question"

California has recently enacted a new set of school accountability laws, curricular standards, a new state testing program and a new promotion/retention law designed to legislatively move California public school classrooms into a standards-based mode. It is easy for teachers, principals, and school districts only to emphasize the content of the state tests in their classrooms. However, there is also a belief that the skills of reading and mathematics are strengthened when taught using engaging, high interest content.

In the spring of 1999, the Board of Trustees of the El Centro Elementary School District asked the district staff about the effect of the kit-based approach to teaching science on student learning compared to the more traditional way of just using textbooks. The Board of Trustees also asked district staff if student achievement in other areas of the curriculum was affected as a result of this approach to teaching elementary science. There were no data available to provide the Board of Trustees with information regarding their questions. District staff designed a plan of action to collect data during the spring of 1999 "testing season" to report to the Board.

The plan of action consisted of administering the Science Section of the Stanford Achievement Test, 9th Edition, Form T to all 4th and 6th grade students. The Stanford Achievement Test, 9th Edition, Form T was adopted by the California State Board of Education in 1997 as the statewide achievement test to measure student achievement in basic academic skills. The Reading, Language, Spelling and Mathematics Sections of this achievement test are the secured state mandated test in California. The Science Section is optional until high school. Under California law, all students who have been enrolled in California public schools for at least one year are required to take the test in English regardless of language background.

The Science Subtest of the Stanford Achievement Test, 9th Edition, Form T (SAT 9) was constructed to mirror the philosophy presented in Science for All Americans (1990). The subtest was constructed to de-emphasize specific content vocabulary and emphasizes the unifying themes and concepts of science. Criteria used by the test constructors to determine these concepts include the idea that the concept should have strong predictive power, be applicable in many situations, guide observation, encourage questioning and represent organizing principles. These are the same criteria that were employed in the National Science Education Standards (1995), which was used to guide the development of the Science Subtest.

The study utilized SAT 9, Form T, Intermediate 1 for Grade 4 and SAT 9, Form T, Intermediate 3 for Grade 6. In the item classification for each subtest, the test constructors classified each item first by the science content that it measured and then according to the science process it assessed.

The content clusters included on both the Intermediate 1 and Intermediate 3 both assess content from earth and space science, physical science, and life science. The test constructors selected content items to assess basic understanding and thinking skills. The items were then classified into one of the following three science processes skill areas: 1) using and analyzing evidence and models; 2) recognizing consistency and patterns of change and 3) comparing form and function.

There are 40 content items on both levels of the test that were used (Intermediate 1 and Intermediate 3). The items are distributed with 12 questions for earth and space science, 14 questions for physical science, and 14 questions for life science. On both levels of the Science Subtest 30, items are designated to assess process skills.

The program assessment analyzed and compared only the scores of students who had been enrolled in the El Centro School District, regardless of school of attendance, for the last four years. This part of the design was to examine student accomplishment only for students who had the potential to be exposed to the district science program during this four-year time interval.

In order to provide information to the Board of Trustees regarding student achievement in other areas of the curriculum, which may have been affected as a result of this approach to teaching elementary science, staff utilized the 6th Grade District Writing Proficiency results from the spring 1999 administration. Student notebooks are an integral part of the science program. Staff believed that the amount of focused writing which is associated with the science program might have an effect on student writing. The prompt of the District Writing Proficiency at the 6th grade level was chosen, as it required the student to develop a plan of action to address an issue that was provided. The assessment was scored using a four point holistic rubric covering content and the conventions of writing.

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The "Results"

All 4th and 6th grade students in attendance during the administration of the Stanford Achievement Test, 9th Edition, Form T were assessed on the Science Section of the test. The data were then first disaggregated to form a group, which included only students, which had attended an El Centro Elementary School District school continuously for the previous four years. This group was then further disaggregated into groups representing the number of years the student had been a member of a classroom that had participated in the district science program.

In the El Centro Elementary School District, all student cumulative records are electronically stored. It is possible to retrieve student data that indicates school, teacher and year of attendance with that teacher. A sub-file for teachers was established which referenced the first year that they had participated in the professional development program and had implemented the district science program in their individual classroom in order to disaggregate the student data and compute years of participation in the district science program.

Table 1 presents the cumulative and disaggregated data for students who had been continuously enrolled in the El Centro Elementary School District for four consecutive years.

Table 1
Stanford Achievement Test, 9th Edition, Form T
Science Section
Spring 1999 Results in National Percentile Rankings
Disaggregated by Student Participation during the 1998-99 School Year

	Gr 4	Gr 6
Cumulative NPR	31(n=630)	40(n=638)
Students Participating in 1999	40(n=393)	59(n=358)
Students Not Participating in 1999	21(n=237)	33(n=280)

The data represents students who participated in the district science program only for the 1998-1999 school year and those students who did not participate in the science program. This number represents 95% of all students tested.

The data from Table 1 indicate that there are distinct differences between students who participated in the district science program during the 1998-99 school year and had been in attendance in the El Centro School District continuously for the prior four years. The data is consistent with that described by Bredderman (1983) in a quantitative analysis of 57 research studies comparing the learning effects of kit-based programs to traditional textbook programs. Bredderman reported a 14-percentile point difference, favoring the kit-based programs. He also found noteworthy improvement for females, economically disadvantaged and minority students. Students who did not participate in the district science program during the 1998-99 school year or in any other year during the years covered by this paper typically received instruction from textbooks or from a unit of individual teacher design. The data is also consistent with a meta-analysis of 81 research studies conducted by Shamansky (1990) contrasting the performance of students in hands-on, activity-based programs with that of students in traditional textbook-based programs.

Table 2 represents the same data disaggregated by number of years of participation in the district science program.

Table 2
Stanford Achievement Test, 9th Edition, Form T, Science Section
Spring 1999 Results in National Percentile Rankings
Disaggregated by Years of Student Participation in District Science Program

	Gr 4	Gr 6
Cumulative NPR	31(n=630)	40(n=638)
Years of Participation		
0	21(n=137)	28(n=158)
1	32(n=150)	32(n=146)
2	38(n=141)	43(n=122)
3	47(n=111)	50(n=114)
4	53(n=91)	64(n=98)

The data in Table 2 indicate a strong trend or relationship between achievement and the number of years of participation in the program. The data is consistent with the reported findings from both Wise (1996) in a meta-analysis of 140 published comparisons between hands-on and traditional textbook programs and Stohr-Hunt (1996) in a study of 24,599 students in 1052 schools with regard to the frequency of hands-on experience strongly influencing student achievement. Both studies reported higher achievement scores for students with more exposure to hands-on learning when compared to traditional textbook instruction.

Table 3 presents the cumulative and disaggregated grade 6 student writing proficiency data for students who participated and did not participate in the district science program during the 1998-99 school year and had four years of consecutive attendance in schools of the El Centro Elementary School District.

Table 3
Grade 6 Writing Proficiency Pass Rate
Spring 1999 Administration

Pass Rate: Cumulative	71%(n=636)
Pass Rate: Students Participating in 1999	89%(n=357)
Pass Rate: Students Not Participating in 1999	58%(n=279)

The data in Table 3 indicate a significantly higher pass rate on the 6th Grade Writing Proficiency Assessment for students who participated in the district science program during the 1998-99 school year.

Table 4 disaggregates the cumulative data by the number of years that students had participated in the district science program if they were in attendance in any El Centro Elementary School District school during the previous four years.

Table 4
Grade 6 Writing Proficiency Pass Rate
Spring 1999 Administration
Disaggregated by Years of Participation in District Science Program

Pass Rate Cumulative	71%(n=636)
Years of Participation	%Pass
0	25%(n=158)
1	58%(n=144)
2	73%(n=122)
3	88%(n=114)
4	94%(n=98)

The data presented in Table 4 indicate a strong relationship between the number of years of participation in the district science program and the pass rate on the 6th Grade Writing Proficiency Assessment.

The "Indicators"

The data was presented at the Regular Meeting of the Board of Trustees in August 1999. While the data is still being analyzed and statistical tests are being conducted for significance, the trends are very apparent for this group of largely poor, rural, Hispanic students. The norm-referenced data indicates a trend between the number of years of participation in a kit-based program of science education and the strength of their scores on a norm-referenced test. This data is consistent with the findings of Shamansky, Hedges and Woodworth (1990) and Kyle (1988) in their reported findings of the strong benefits of hands-on science education for students from lower socioeconomic and rural backgrounds. There are also trends and indications that the science notebooks used with the program to stimulate focused writing experiences may transfer to an overall improvement in writing.

The District staff and researchers from San Diego State University, Imperial Valley Campus are currently conducting a similar analysis of the same student data to determine trends in mathematics achievement, especially in the areas of measurement, problem solving and relations/functions/statistics to examine any potential "transfer" value that the science program may offer. Additional analysis is also being conducted to determine the effects of instruction related to the achievement of English Language Learners.

Limitations

While the initial findings of this study are very promising, it must be noted that data was gathered from one point in time. Further study on these students and others in the VIPS Project will allow for a larger pool of longitudinal data where the achievement of each participating student can be followed over time. These continuing studies will hopefully shed even more light on the relationship between sustained teacher professional development, fidelity of implementation, inquiry-based science, the use of science notebooks, and student achievement.

Next Steps

While the data indicates strong trends with a cohort of students, additional work needs to be conducted regarding the significance of these findings. In addition, these findings have led to new questions regarding the acquisition of language from a student population that is largely language minority and to effective teaching practices associated with these early results. These issues will be investigated over the next several years. In addition this study will be replicated over the next several years examining new cohorts of students.

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