

**EVALUATION OF THE
WATERFORD EARLY MATH & SCIENCE PROGRAM
FOR KINDERGARTEN:
First-Year Implementation in Five Urban
Low-Income Schools**

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ABSTRACT

Evaluation of the Waterford Early Math & Science Program for Kindergarten: First-Year Implementation in Five Urban Low-Income Schools

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Background: The Waterford Early Math & Science (WEMS) program is a comprehensive educational software program designed to build math and science skills and concepts in grades K-2, alone or to supplement existing curricula. The program's capability to individualize lessons, assess and track student progress, and reteach lessons is aimed at keeping potentially "at risk" students at grade level.

Purpose: The present evaluation of the Waterford Early Math & Science program is the first independent study of its effectiveness.

Setting: The study was carried out in five low-income, largely Hispanic schools during the 2005-06 school year.

Study Sample: This report covers the 22 kindergartens (345 students) from a larger sample of 59 K-2 classrooms (923 students) in the five schools.

Intervention: Treatment classrooms were provided with four to six computers loaded with the Waterford Early Math & Science program. The teachers received initial and on-going training in its use and were instructed to give every student at least four 22-minute sessions on the program each week.

Research Design: The study used an experimental design in which classrooms were assigned through a process of stratified random selection to the treatment (Waterford Math & Science program) or control group.

Control or Comparison Condition: Control classrooms were to use the district curricula and any supplemental programs or educational software already in use, except for Waterford Early Math & Science.

Data Collection and Analysis: Data collected included pretest data on student achievement in math and science in the fall, and posttest data on the same in the spring. The Stanford Achievement Test (SAT10 Form A, SESAT1 and SESAT2) provided the pre-post measures for math and the environment (science). Usage data stored in each computer provided the measure of exposure to the program. Usage was filtered at 1100 minutes corresponding to six months of 45 minutes a week in order to see program effects on student achievement. Statistical analyses included paired and independent sample *t* tests, analysis of covariance, and chi-square tests for non-parametric measures. Treatment and control groups were also analyzed by subgroups of gender, ethnicity, primary home language, English language learner (ELL) status, pretest achievement quartile, and by program dosage.

Classroom observations of a sample of treatment and control classrooms, focus groups of the treatment teachers, principal interviews and surveys of all treatment and control teachers provided data on the level of implementation of the program, equivalency of conditions, and attitudes toward various aspects of the program.

Findings: The most significant findings for kindergarten were:

- Qualitative data showed the attitudes of the treatment classroom teachers and principals to be very favorable toward the program;
- The general level of implementation was as expected for first-year implementation, with moderately high use of the software and limited use of supplementary materials;
- WEMS students significantly outperformed the control students in math and the environment tests;
- Program effect sizes were moderate;
- When compared with their counterparts in the control classes, the WEMS students made significantly greater gains in math and the environment tests in the case of boys, girls, Hispanics, Spanish home language students, and ELL students;
- WEMS English home language students and English-proficient (non-ELL) students also made significantly higher gains in the environment test than their control counterparts;
- WEMS Spanish home language students and WEMS ELL students made significantly greater gains than other WEMS and control students and scored above the national mean on both tests;
- Kindergartners at all levels of program usage made greater gains than the controls on both tests.

Native American, African American and white children showed greater gains in the WEMS classrooms than in the controls, but their samples were too small for results to be conclusive.

Conclusion: The WEMS program appeared to benefit all children in kindergarten, particularly Hispanics, students whose primary home language was Spanish, and English language learners.

1. Teacher and principal attitudes

Focus groups, interviews, conversations with the teachers during class observations, and surveys were used to determine the attitudes of teachers and principals toward various aspects of the WEMS program. The attitudes investigated concerned WEMS training and support, technical issues, implementation, the quality and content of the program, and student response and achievement.

Attitudes toward technology, technical aspects

Teachers appreciated how easy the program was to use and how little direct maintenance it required once it was running. They especially liked that the children could manage the rotations themselves. The teachers noted that the kids seemed to really love the program. One principal noted, "It's like having four other teachers in the room who never lose their patience."

Attitudes toward the quality and content of the program

Teachers and principals agreed on the high quality of the WEMS program. Technology was seen as one more opportunity to meet the diverse needs of the students. Teachers and principals specifically mentioned the comprehensive nature of the program, the quality of the graphics and sound, the ability to track student progress, and the variety of activities in different modalities such as music. They liked that it was self-paced, had different levels, could print reports, and engaged the students extremely well. They also mentioned its usefulness for vocabulary development and listening skills. The movies and science lessons were judged to be especially good. According to the teachers and principals, the testing, diagnostic assessments and tracking of student progress put it above other computer-based and internet instructional resources.

Teachers especially appreciated the integration of math and science. Many teachers welcomed the additional exposure and expressed their frustration at not being able to do more science activities in the classroom because of time constraints.

Attitudes toward student engagement with WEMS

All teachers and principals in the surveys, observations, focus groups and interviews noted the enthusiastic response of the children to the program. Students picked up how to use the computer quickly and motivation remained high, even at the end of the year, in contrast to other computer-based instructional programs. The program engaged students who were not usually engaged. Students would ask: "Why haven't I gone yet?" "This is interesting." "When is it my turn?" Because of the high level of interest, teachers found WEMS a good motivational tool as well as an instructional program. Students from other classes sometimes came in and wanted to use the program but were denied.

2. Achievement

Determining the effect of the WEMS program on student achievement was the main purpose of this evaluation. Qualitative data was collected from teachers and principals from focus groups, interviews, conversations, and surveys. In general, findings suggested that the effect of the program was positive, with teachers who scheduled heavy use of WEMS responding more positively. Quantitative data relating to program effects consisted of results from the Stanford Achievement Tests in math and the environment and records of usage of the WEMS program for each student. Achievement scores were compared across the treatment and control groups and by subgroups. Select results from these analyses are presented below.

Gains by School

In math, kindergartners in WEMS classes made greater gains than controls at all five schools, and WEMS students had significant pre to posttest gains at all schools (see Figure 1).

On the environment test, results were similar. Students in the WEMS classes made greater gains than controls at all schools (see Figure 2).

Figure 1. Kindergarten SAT10 Math Gains

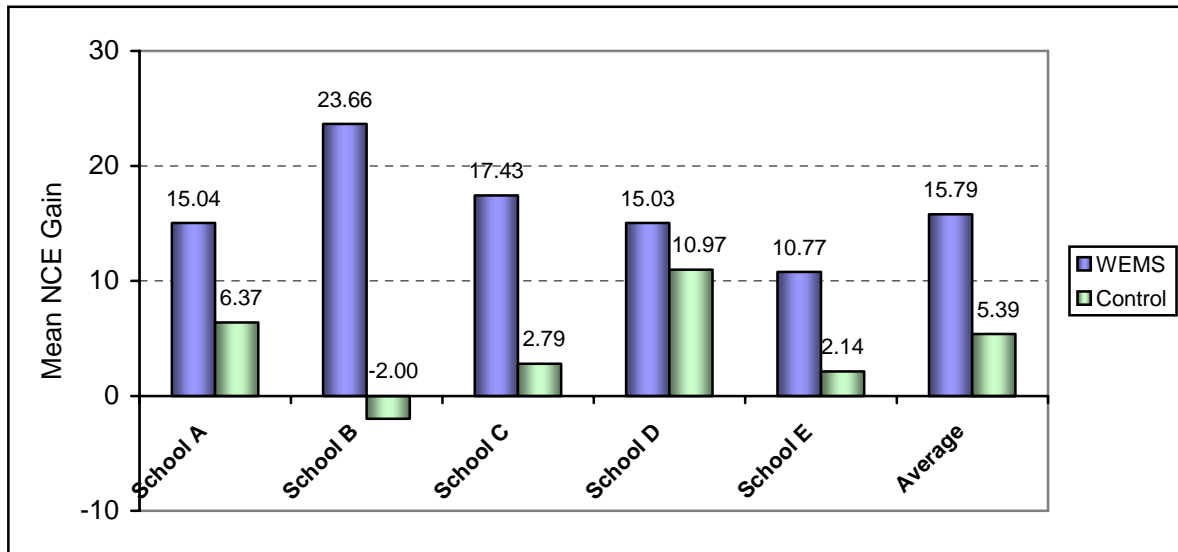
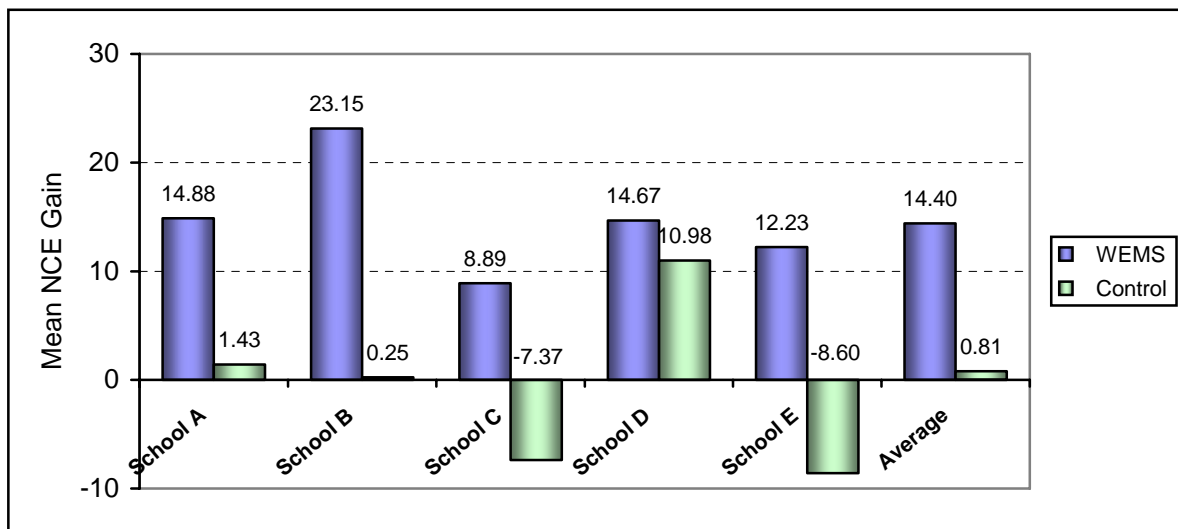


Figure 2. Kindergarten SAT10 Environment Gains



Ethnicity

Hispanic WEMS kindergartners outperformed the controls in math and the environment. African Americans, Native Americans and white WEMS kindergartners made greater gains than the controls, although these were not statistically significant. The small numbers of African Americans, Asians and whites made attaining statistical significance problematic; for example, the Asian control group consisted of one student (see Figures 3 and 4).

Figure 3. Kindergarten SAT10 Math Gains by Ethnicity

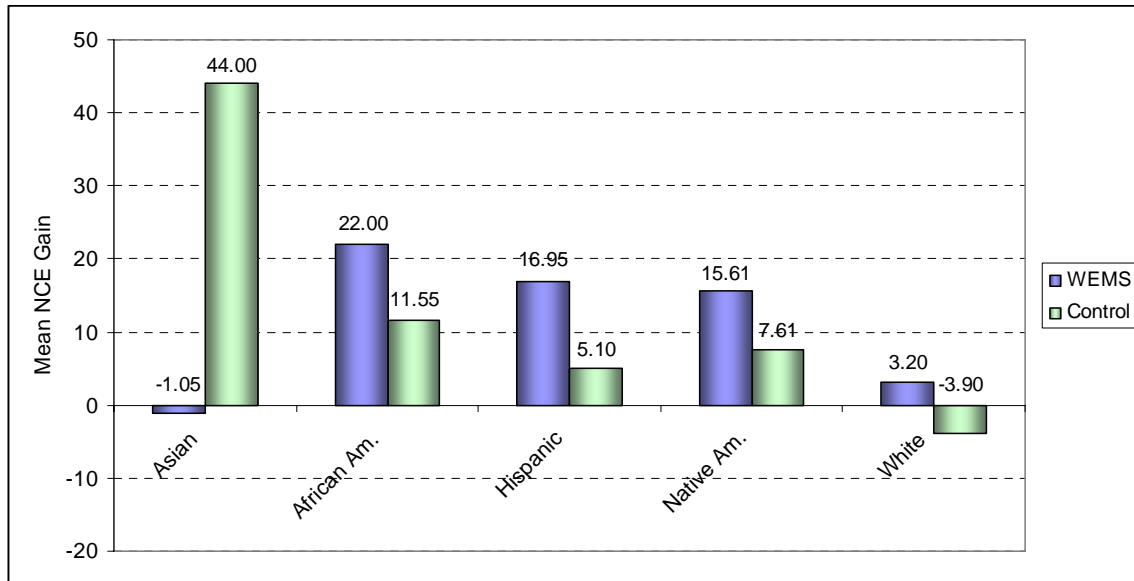
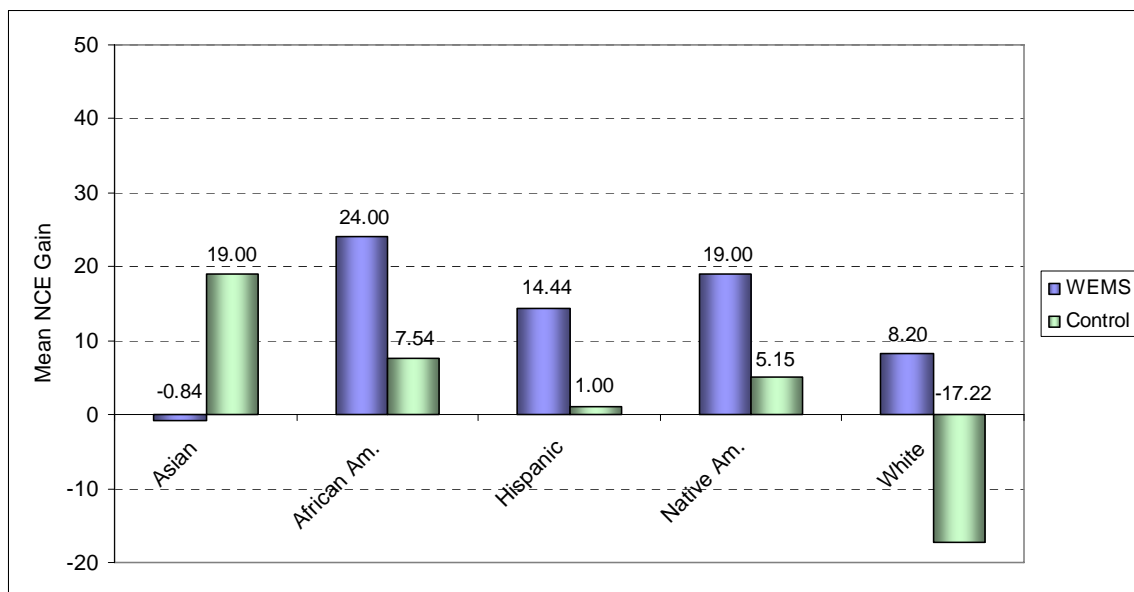


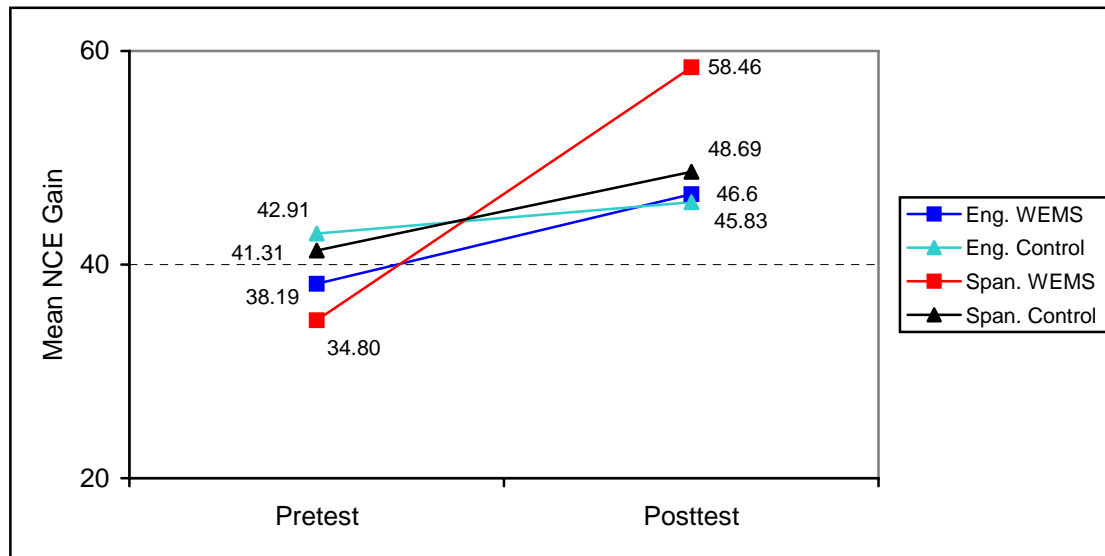
Figure 4. Kindergarten SAT10 Environment Gains by Ethnicity



Primary home language

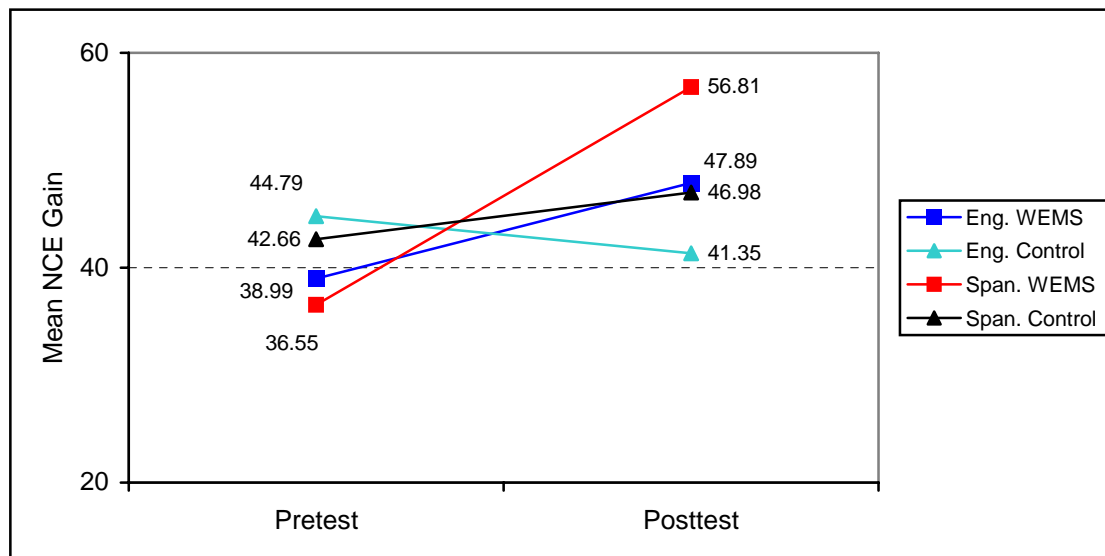
WEMS students whose primary home language was Spanish made significantly greater gains in math than the controls. In fact WEMS Spanish home language students, who scored lowest on the pretest, outperformed all other groups on the posttest and scored above the national mean. Significant pre to posttest gains on the SAT10 math test were made by WEMS English home language students and both WEMS and control Spanish home language students (see Figure 5).

Figure 5. Kindergarten SAT10 Math Pre-Posttest Scores by Primary Home Language



On the environment test, the difference in gains between the WEMS and control groups was significant for both English and Spanish home language students. WEMS students made significant pre to posttest gains whether their primary home language was English or Spanish. As in math, the WEMS Spanish home language students, who scored lowest on the pretest, outscored all other groups on the posttest and scored above the national mean (see Figure 6).

Figure 6. Kindergarten SAT10 Environment Pre-Posttest Scores by Primary Home Language

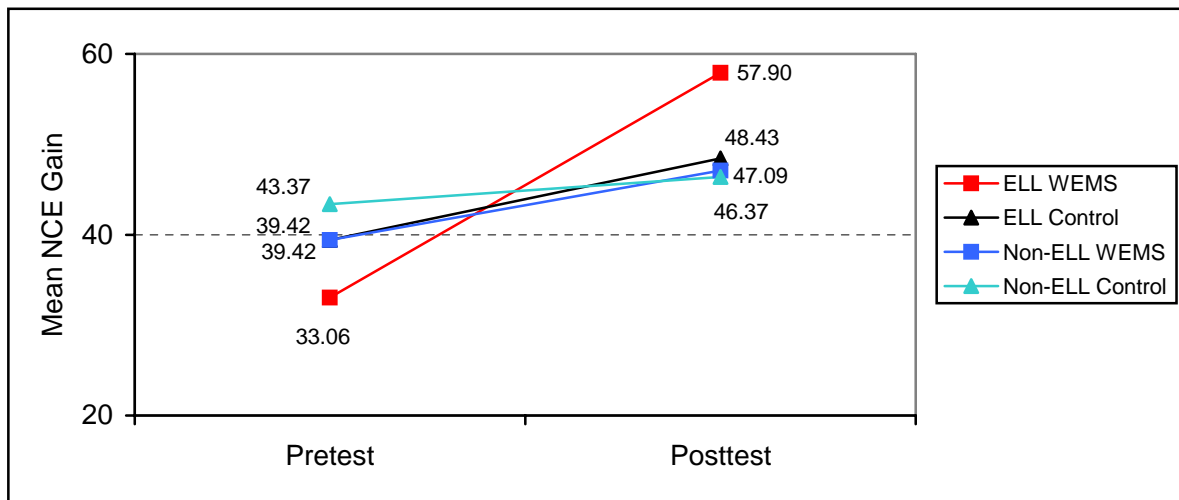


English Language Learner status

WEMS ELL students made significantly greater gains than control ELL students on the math and environment tests. WEMS English-proficient (non-ELL) students also significantly outperformed control English-proficient students on the environment test. ELL students made significant pre to posttest gains on the math and environment SAT10 tests in both the WEMS and control groups. In addition, the WEMS non-ELL students made significant pre to posttest gains in math and the environment.

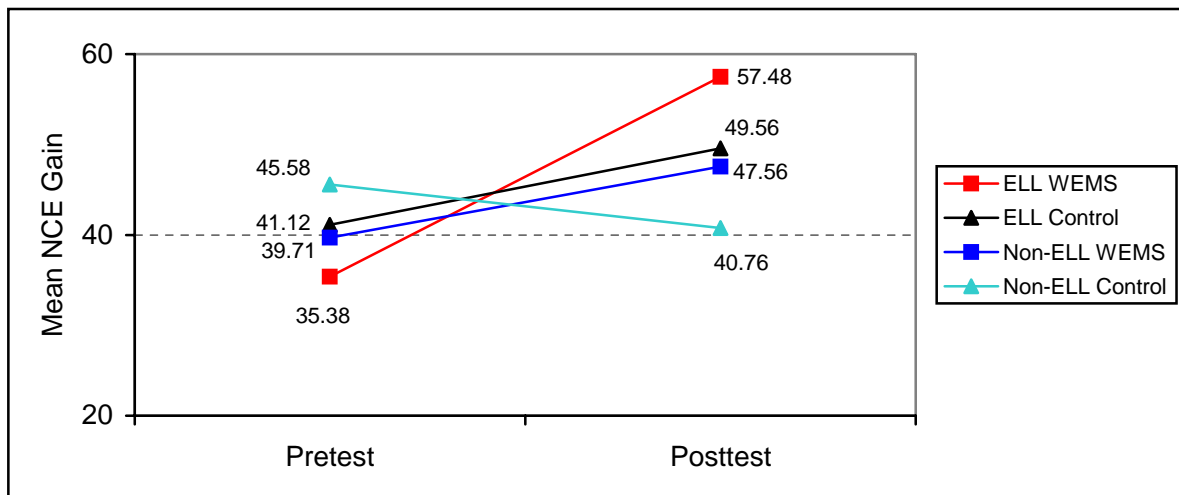
As was the case with findings regarding students' primary home languages, WEMS ELL students had the lowest pretest scores in math, yet received the highest posttest scores, which were above the national mean. Other groups made more modest gains (see Figure 7).

Figure 7. Kindergarten SAT10 Math Pre-Posttest Scores by ELL Status



On the environment test, WEMS ELL students scored lowest on the pretest but outperformed all other groups on the posttest, again scoring above the national mean. Control ELL and WEMS non-ELL students made more modest gains (see Figure 8).

Figure 8. Kindergarten SAT10 Environment Pre-Posttest Scores by ELL Status



Ethnicity, primary home language and ELL status

Converging results from the subgroup analyses by ethnicity, primary home language and ELL status suggest that Hispanic students in particular benefited from the WEMS program. WEMS Spanish home language and ELL students not only made significantly greater gains than controls, but outperformed both their control counterparts (the English-proficient and English home language students) on the math and environment tests, scoring above the national norm.

3. Summary of notable findings

The most important findings for the Kindergarten classes were:

- Qualitative data showed the attitudes of the treatment classroom teachers and principals to be very favorable toward the program;
- The general level of implementation was as expected for the first-year of use;
- WEMS students significantly outperformed control students on the math and environment tests;
- WEMS boys significantly outperformed control boys, and WEMS girls significantly outperformed control girls on the math and environment tests;
- WEMS Hispanic students significantly outperformed controls on the math and environment tests;
- WEMS Spanish primary home language students significantly outperformed controls on the math and environment tests;
- WEMS Spanish home language students also outperformed English home language controls on both tests and scored higher than the national mean in math and the environment
- WEMS English home language and English-proficient students significantly outperformed their control counterparts on the environment test;
- WEMS ELL students significantly outperformed the ELL controls on the math and environment tests; and
- WEMS ELL students outperformed English-proficient controls and scored above the national mean on both tests.

4. Closing the gap

The strong performance of WEMS students with Spanish as their primary home language and WEMS ELL students suggest that the WEMS program may be an effective strategy for closing the academic gap between these students and English-proficient students.

These results suggest that the WEMS program helps both English speakers and ELL students, but may help ELL students more. The WEMS program aims to provide a degree of individualized instruction and tracking of progress that a teacher or aide can only provide during one-on-one

interactions. While teachers noted that some students continued to need one-on-one help, the WEMS program efficiently provided enough individualization to suit the majority of students' needs. Several teachers commented that their ELL students were slow to catch on to the program but over time these students became more comfortable and were able to effectively interact with the software. Some teachers found that sitting with a child for a session or two to provide instruction and guidance in their primary language improved the student's understanding of the program. It would seem that once ELL students learned the mechanics of the program and acquired some basic instructional language they were able to take advantage of the features of the program (consistency of language, repetition, and visuals) to experience success.

5. Technology in education

The role of technology in education is two-fold: to harness the capabilities of technology to further educational goals, and to train students in the use of technology as a tool to apply to different endeavors. The WEMS program meets these roles as it tracks student progress, delivers reports to the teacher, and adapts to the needs of the students, essentially serving as a supplementary classroom teacher. The WEMS technology also provides a different modality to help children learn. In addition, simply using the program familiarizes children with technology. For example, some teachers commented that their girls seemed more comfortable with the computers than girls had been in the past.

These results from a first-year implementation (with only partial use of the supporting materials) coupled with the enthusiastic response of teachers and principals to the program suggest that the WEMS program could be expanded to all kindergarten classrooms in these schools and in similar schools and districts across the country, particularly those with high Hispanic and ELL populations. In general, findings from this evaluation suggest that implementation of the WEMS program in early childhood classrooms could be an effective strategy to help close the achievement gap for at-risk children, particularly for ELL and Spanish primary home language students.