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Multimedia Educational Program Increases Science Achievement Among Inner-City Non-Asian Minority Middle-School Students

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Abstract

This study tested the effectiveness of a middle-school, multi-media health-sciences educational program called HEADS UP in non-Asian-minority (Hispanic and African American), inner-city students. The program was designed to increase the number of non-Asian minority students entering the academic health-sciences pipeline. Students of Asian ethnicity were excluded because they are not underrepresented in science professions. The curriculum modules include video role-model stories featuring minority scientists and students, hands-on classroom activities, and teacher resources. The modules (evaluated from 2004-2007) were developed through collaboration among The University of Texas Health Sciences Center, the Spring Branch Independent School District, and the Health Museum, Houston. A quasi-experimental, two-group pre-test/post-test design was used to assess program effects on students' performance, interest, and confidence in their ability to perform well in science; fear of science; and confidence in their ability to pursue science-related careers. An intervention school was matched to a comparison school by test scores, school demographics, and student demographics. Then, pairs of sixth-grade students (428 students) were

matched by fifth-grade scores in science and by gender, ethnicity, and poverty status (free or reduced lunch) and followed up for three years. At eighth grade, students from the intervention school scored significantly higher ($F=12.38$, $p<0.001$) on the Stanford 10 Achievement Test in science and reported higher interest in science ($F=11.08$, $p<0.001$) than their matched pairs from the comparison school. HEADS UP shows potential for improving inner-city minority middle school students' performance and interest in science and is an innovative example of translating health-sciences research to the community.

Keywords

science education; non-Asian minority; Hispanic and African American minority students; multimedia curriculum; educational program

Introduction

Colleges in the United States are no longer graduating enough students with science majors to meet the demand for scientists who can assume leadership roles in the science professions.¹ This deficit begins in kindergarten and continues through twelfth grade (K-12) schools. In 2005, only 29% of fourth and eighth grade students and only 18% of twelfth grade students performed at or above the proficient level on the National Assessment of Educational Progress (NAEP) science test, and US science scores had improved very little since 1996.² Compared to students in Asian and European countries, US students continue to rank poorly, with non-Asian (Hispanic and African-American) minority students lagging even further behind in performance when compared to White and Asian students.¹ Therefore, an urgent need exists in the United States to improve science instruction and achievement in K-12 and, even more importantly, to address the instructional deficiencies in science curricula in inner-city public schools, which educate the majority of non-Asian minority students.

Many minority youth lack minority role models, including teachers, to encourage and inspire their interest in science. In 2003-2004, 18% of students in the United States were Hispanic; however, only 6% of K-12 teachers were Hispanic.² In Texas, the discrepancy between student and K-12 teacher ethnicity is even more striking. In 2004, 44% of Texas students were Hispanic, yet only 19% of Texas teachers were Hispanic.³ In college, non-Asian minority students are underrepresented in science, technology, engineering, and math (STEM) courses and, when they are enrolled in STEM courses, they are more likely to drop out of school or change majors.⁴ From 1997-2001, only 8% of science PhDs from 35 top institutions were African American, Hispanic, or Native American, providing a small pool for minority role models in faculty positions at the university level.⁵

To improve students' interest and competence in science, the current instructional environment needs to change so that more students enter the pipeline to health-science careers. Many researchers strongly believe that the middle-school grades may be the last chance for effectively intervening to correct students' misperceptions about science and their deficiencies in preparation for continuing in a science career.⁶ Research has shown that students who enjoy science and are successful at the middle-school level are more likely to choose and be successful in science courses at the high-school level,⁷ and eighth-grade students who expect to work in science-related careers are more likely to graduate from college with science degrees.⁸

We designed a state-of-the-art multimedia science program for middle school students called HEADS UP (**H**ealth **E**ducation **A**nd **D**iscovering Science While **U**nlocking **P**otential) to

enhance minority students' competency and interest in science courses at the middle school level. HEADS UP is composed of select topical educational modules delivered by minority science experts. The ultimate goal is to increase the number of students in the pipeline for health careers and leadership roles in the sciences. With funding from the National Institutes of Health, we were able to implement HEADS UP and to assess the effects of the program at eighth grade for a cohort of inner-city sixth-grade students from low socioeconomic, non-Asian (Hispanic and African American) minority homes.

HEADS UP Science Teaching Modules

Investigators at The University of Texas Health Science Center at Houston School of Public Health (Houston, TX) designed a series of educational science modules called HEADS UP (**H**ealth **E**ducation **A**nd **D**iscovering Science While **U**nlocking **P**otential) to determine whether the modules could effect changes in students' performance, interest, and confidence in their ability to perform well in science; decrease their fear of science; and enhance their confidence in their ability to pursue science-related careers; and to support teachers in planning and delivering quality instruction. We enlisted scientific experts from across The University of Texas Health Science Center, master teachers from the Spring Branch Independent School District (Houston, TX), and health educators from the Health Museum in Houston to participate in developing the modules.

This team determined the program goals, performance objectives, and learning objectives through an "intervention mapping process,"^{9, 10} which is a system used to facilitate collaboration between researchers and practitioners in utilizing theory, empirical evidence, and experience to develop program materials. The intervention mapping process creates complex tables with performance objectives and theoretical change strategies as the axes of the tables. For HEADS UP, the overall program goal was increased performance (Stanford Achievement Test 10) and interest in science (ie, having students say, "I can do that."), which was manifested as interest in science, confidence in ability to perform well in science, reduced fear of science, and confidence in ability to pursue science-related careers/occupations (self-efficacy). Teachers and science curriculum specialists identified specific Texas Essential Knowledge and Skills (TEKS)¹¹ as performance objectives for students to meet as a result of using the program. In particular, standards not adequately covered in an existing science curriculum were identified and developed into modules, ie, Genetics (Genes Health & You), how systems work together (Diabetes/Cardiovascular Disease, Nutrition/Physical Activity), how systems work individually (The Nervous System). The modules include information about the history of science and the processes of science. The team also identified performance objectives for teachers regarding program usage and professional development.

Also included in the intervention tables were theories and methods in behavioral health science research about how learners process and acquire information, including attitudes, outcome expectancies, skills, perceived norms, and self-efficacy. Self-efficacy was defined as a belief in "one's capabilities to organize and execute the courses of action required to produce given attainments."¹² The collaborators then designed the materials to positively affect the learning objectives described in each cell of the mapping tables through information transmission, modeling, guided practice, skills training, reinforcement, and social support. For example, video stories in the HEADS UP modules provide vicarious learning experiences designed to increase self-efficacy through video stories modeling support from families and peers for expressing an interest in science. In the Diabetes/Cardiovascular Disease module, Hispanic role models are used because diabetes and cardiovascular disease are especially prevalent in the Hispanic population.¹³ The Genes, Health & You module incorporates a story about a student who learns from her aunt, who is a geneticist, of the role genetics plays in her family's predisposition to diabetes. The Nervous

System module incorporates a story line about a student who suffers a concussion from a skateboard accident. In the story, the student's friends question health care providers about the causes and consequences of their friend's concussion, and the health care providers explain how a concussion affects the functioning of the nervous system. Thus, videos in the Nervous System module are designed to encourage students to ask questions of experts by modeling the reward of respectful and enthusiastic answers from experts. Guided practice and skills training are provided through classroom activities, active learning that enhances learning and motivation and may result in higher science achievement¹⁴ and higher retention.¹⁵ Wherever possible, the modules present material graphically because graphics facilitate effective encoding of information.¹⁶

This design process was iterative, with review and feedback from teachers, science curriculum specialists, experts, and media specialists that resulted in revisions. The final HEADS UP science modules consist of videos on DVD or VHS cassette tapes; overheads; simply written teacher information sheets for each topic designed to enhance teachers' professional development and self-efficacy; timelines and classroom activity descriptions, which provide sufficient information [time required, standards alignment, materials needed]; graphics and assessment tools, which teachers can format and adapt; and Web-based resources. Videos are linked to standards, are short, incorporate graphics, and include content information in a story format with modeling from students and scientists. Video career stories of these scientists, many of whom are minorities and several of whom are women, are one of the most important features of HEADS UP. Feedback from teachers during the iterative process confirmed that their students saw themselves reflected in the students featured in the videos as well as the scientists in the career stories – identifying with scientists from families like their own, and concluding “I can do that!”

During the iterative process, teachers also suggested that classroom activities be developed to complement the videos, so teachers were hired as consultants to create the activities. Master teachers created activities that could be easily used in the classroom and that would fit into existing campus/district curricula; activities met TEKS standards and considered different student capability levels. To increase usage, HEADS UP is designed to make the content appealing to teachers and easy for them to use. Information sheets were developed for each topic to allow for teachers' professional development. The classroom activities developed vary for the modules, but may include worksheets, hands-on exercises requiring simple supplies, individual and group participation activities, case studies, and problem-based learning. A key feature of HEADS UP is dictated by our philosophy that the teacher is the expert in teaching and can most effectively manage classroom time and need, so activities are designed as a menu from which teachers can pick and choose. Teacher feedback has confirmed this feature enhances their interest in the program and their use of the materials.

Teacher Training

In the first year, three teacher training workshops were conducted for the eight participating HEADS UP middle-school science teachers, and a follow-up training session was conducted in the second year. As part of the training, teachers carefully evaluated all HEADS UP content and aligned elements with their district curriculum for implementation in the sixth through eighth grades. These materials are “turn-key” packages designed for easy utilization, with limited need for training. Three of eight teachers applied for additional professional development, which included two annual five-day Teacher Summer Science Institutes hosted by the HEADS UP project team.

Evaluation Goals and Design

For this study, we wanted to determine the effect of the HEADS UP modules on non-Asian minority (Hispanic and African American) students' performance in science, interest in science, confidence in their ability to perform well in science, fear of science, and confidence in their ability to pursue science-related careers/occupations (self-efficacy). A quasi-experimental, two-group pretest/post-test design was used to assess program effects. To facilitate the achievement of baseline equivalence between the students in the intervention program and those in a comparison group, two levels of baseline matching were adopted by an external evaluator. First, a school targeted for the intervention was selected from the inner-city school district. Then, a comparison school was selected from the same district. The schools had similar institutional and community demographics and academic performance levels (Table 1). Second, for each participating student from the intervention program school, the evaluator selected a matched student from the comparison school. Matching was done based on low socioeconomic status as indicated by inclusion in the free/reduced lunch program, ethnicity, gender, and fifth-grade SAT10 scores in science. Asian minority students were excluded from the analysis. This cohort of matched pairs was followed from sixth to eighth grades (2004–2007).

We used a matched-pairs design for comparison in this study because randomized assignment of students to the intervention and comparison groups was not feasible and would have presented problems of internal validity. Most inner-city public schools have only a few science teachers, and those teachers concurrently teach all students in one or more grade levels. Therefore, the most realistic way to implement the initiative, and, subsequently, to obtain the most valid data, was to place all of the sixth-grade students in the targeted middle school into the intervention group and to select another matched school from which to draw a comparison group of students. This design provided an adequate measure of careful control.

Both middle schools were located in a large US Southwestern inner-city school district with district-wide enrollment in excess of 200,000 students. The school targeted for the intervention program had approximately 1,100 students, of whom 88% were Hispanic, 11% were African American, and 1% were of other ethnic origins. Those of “other ethnic origins” were excluded, including any Asian students. The comparison school had approximately 1,200 students, of whom 96% were Hispanic, 2% were African American, and 2% were of other ethnic origins. Throughout the study period, both schools maintained 48% male and 52% female students. All available sixth through eighth-grade students participated in baseline assessments for validation of measurement instruments (Table 1).

For each HEADS UP intervention student, a matched pair was selected from the comparison school's pool of eligible students; the paired student had the same or similar socioeconomic status, ethnicity, gender, and science scores. By adhering to this selection process, intergroup baseline differences were substantively eliminated to enable the two groups to achieve the equivalence that random assignment of subjects seeks to achieve in experimental studies. The effect of lost-to-follow-up was also minimized by the matched pairs design. By using a matched-pairs design, the baseline free/reduced lunch status, ethnicity, gender, and performance levels remain the same even if the sample size declines. In effect, the demographic composition of the HEADS UP cohort and that of the comparison cohort always remained the same, regardless of changes in the size of the matched sample, thereby ensuring that the post-test reflected a true comparison.

Measures and Analysis

The main outcome measure for performance in science was the end-of-year scores on the SAT10 in science that were provided by the school district to a third-party evaluator. Scores in reading were included in the analysis to assess differential effects. The HEADS UP program modules were designed to impact science scores with few elements expected to impact reading scores. Math scores on the SAT10 were also included, and since there were some elements of the HEADS UP curriculum related to math, there is some possibility of an impact on math scores. The SAT10 in science is designed to be aligned to both state and national standards¹⁷ and, therefore, is an appropriate measurement tool for a program designed with performance objectives for students to meet state and national science standards.

Two survey instruments adapted from the Student Science Questionnaire¹⁸ and the Student Occupational Questionnaire¹⁹ were administered by a third-party evaluator in science class to assess changes in student attitudes toward science and science careers. These measures test the learning objectives developed through the intervention mapping process: attitudes or interest in science, outcome expectancies or fear of science, and self-efficacy or confidence in science and self-efficacy for science-related careers. Both survey instruments were administered at the beginning of the first year of the intervention and at the end of the third year (late spring) to all students in the cohort grade, whether or not they were included in the matched pairs. These two survey instruments were also administered to all sixth, seventh, and eighth grade students in the participating schools during the first year of the intervention. A factor analysis on data collected at baseline (Student Science Questionnaire) from a sample of 1,968 sixth through eighth-grade students in participating schools¹⁸ confirmed the following three domains: level of interest in science (Cronbach's $\alpha = .82$), science-related confidence (Cronbach's $\alpha = .70$), and fear of science (Cronbach's $\alpha = .71$). For each student in the matched pair cohort analysis, the mean scores of the three domain areas were calculated and used in an analysis of covariance model, with the first-year scores serving as covariates.

Student perceptions of their ability to learn to pursue science-related careers/occupations or self-efficacy for science-related careers were assessed with the Student Occupational Questionnaire, a measure that demonstrated adequate validity and reliability in a sample of Italian schoolchildren of similar age¹⁹ and adequate internal validity (Cronbach's $\alpha = .84$ for science-related occupations) in the full baseline sample for this study. Student scores from questions regarding ten science-related occupations were selected from the 68-item instrument. With each item rated on a Likert scale of 1 (very unsure) to 6 (very sure), the average of the sum of ten scores from each student in the matched pairs was used to calculate the changes in self-efficacy for science occupations during the two-year period.

Implementation of the Modules

Interviews and surveys revealed that the sixth, seventh, and eighth-grade teachers integrated a moderate amount of content (50-60%) from the following modules into their instructional activities during the three years of the evaluation (2004-2007): Genes, Health & You, Diabetes/Cardiovascular Disease, Nutrition/Physical Activity, and The Nervous System. The modules are designed as a multi-element, supplementary resource (videos, classroom activities, assessments, etc.) that can be easily and flexibly integrated into the existing curriculum to add interest for the students and are not designed to replace a major portion of the science curriculum. Ideally, the modules will be used as units based on the suggested timeline and remain structured as suggested. However, the realities of grades 6-8 science instruction in inner-city schools may keep this ideal use from being met, which should not devalue the merits of the impact assessment.

Sub-group Analysis

As a proxy for a dose-response analysis, we conducted a sub-group analysis of students in one eighth grade science classroom whose teacher was assessed to be a high implementer, using 75-90% of module content. This teacher was not considered to be exceptional, based on feedback given by the principal, other teachers, and students. In fact, the HEADS UP team encouraged her to use the modules during the last year of the evaluation because both the principal and the teacher agreed that she was struggling with her class. This teacher's students were identified and compared to their respective matched-pair peers from the comparison school.

Human Subjects

The study protocol was approved by The University of Texas Health Science Center Institutional Review Board and implemented as a component of Project GRAD (Graduation Really Achieves Dreams) activities as approved by the participating school district. Access to the school data was limited to the third-party evaluator, who removed all personal identifiers and linked pre- and post-test scores by a unique study identification number. All analyses and reports were presented in the aggregate to protect students' privacy.

Results

Participation

Of the intervention school's 314 sixth-grade students, 300 students had baseline data (ie, fifth-grade scores in science) which could be included in the assessment of program effects. Of the comparison school's 342 sixth-grade students, 314 had baseline scores. Only students with pretest or baseline science scores were included in the study. In addition, participation in the assessment of program effects required that the students had post-test scores and were on grade level (eighth grade) in 2006-2007. Consequently, in the intervention group, 214 students were included in the third-year, post-test analysis. Of those 214 students, 199 had both the post-test data and scores on the other two survey instruments assessing attitudes toward science and science-related careers. For the final sample, 45.8% were girls, 54.2% were boys, 94% were Hispanic, and 6% were African-American. Attrition analysis revealed no significant differences in SAT10 scores or questionnaires between students lost to follow-up and those retained in the sample.

Performance in Science

An analysis of covariance between the HEADS UP students and the comparison group showed that the intervention program students significantly outperformed their comparison peers in science on the SAT10 ($F=12.38$; $P=0.001$), with a program effect size of 0.23 (Table 2). The HEADS UP 50th percentile placement in comparison group ranking was 59th in science, a 9 percentile point gain. The performance levels between the HEADS UP intervention students and the comparison students in reading and math were not statistically significant, and we would not expect a significant effect on reading as the program is not designed to impact reading performance. There were some elements of the program that might have impacted performance in math.

Student Attitudes Toward Science and Science Careers

The post-test gain in interest in science by the HEADS UP group was statistically significant relative to the scores of their matched comparison peers ($F=11.08$, $P<0.001$), with a moderate effect size of .32. The post-test measures of self-confidence of the HEADS UP students in their ability to do well in science and their fear of science were not statistically significant (Table 3). Both the HEADS UP intervention students and the matched

comparison students experienced slight but similar declines in their self-efficacy to pursue science-related careers during the three-year period. Fifteen pairs were lost to follow-up because of absences in the comparison school on the day the Student Science Questionnaire was administered.

Sub-Group Analysis

We identified 31 matched pairs for the subgroup analysis of the achievement test scores, with 29 pairs for the surveys. Students in the classroom of the high-implementing teacher scored higher on the SAT10 in science, with a 0.41 effect size (16 percentile points higher) and achieved significantly higher scores in math (0.70 effect size, 26 percentile points higher). It is possible that this high-implementing teacher also used the module components related to math, or that these students were participating in an additional math program. Intervention program students reported higher interest in science (0.72 effect size) and decreased fear of science (ie, less fear of science) (0.43 effect size) (Tables 4 and 5). Intervention program students did not report significantly higher confidence in their ability to do well in science. While intervention students reported an increase in self-efficacy for science-related occupations compared to their matched comparisons, ($F=3.82$, $p=.055$), these effects are suggestive but inconclusive.

Limitations

This study was somewhat limited by design, implementation, and attrition, but benefitted from a carefully matched comparison cohort study and the participation of one high-implementing teacher. Budget constraints prohibited a rigorous group-randomized trial design that would have ideally required 16 to 20 schools willing to be randomized to experimental or control conditions.²⁰ The carefully controlled matched-cohort design with a stage-one matching of schools based on factors related to academic performance in a primarily minority, non-Asian (Hispanic and African American) inner-city district, and a stage-two matching of students between intervention and comparison schools provided the most rigorous design within budget constraints. In addition, because the analysis was not an en-masse or entire grade level assessment between the HEADS UP intervention and comparison students, the attrition rate should not have had any substantive effect on the integrity of the impact assessment. If the study had been an en-masse assessment, then there would have been a need to discuss the internal compositional changes within the two groups between the first and the third years. The limitation of moderate implementation of the HEADS UP intervention was also assessed through the subgroup analysis of students in the classroom of the high-implementing teacher. This study is an excellent example of an efficacy study in a challenging, real-world setting in an inner-city minority school district.

Conclusions

HEADS UP resulted from a partnership between an academic health science center, a school district, and a health museum and focused on enhancing teacher resources to engage minority students in science, thus potentially increasing the numbers of students entering the pipeline for leadership roles in the sciences. Our results show that the HEADS UP intervention program improved non-Asian (Hispanic and African American) minority students' interest in science and performance in science on a national achievement test. In addition, the sub-group analysis showed that when a teacher implemented more elements of the intervention program, students scored even higher. They became more interested in science, their test scores were higher, and they had less fear of science. Others who have studied effective instructional programming have seen this same effect: the higher the quality and level of implementation, the greater the impact on students.^{21, 22} The increase in interest in science among these primarily Hispanic and African-American eighth-grade

students is important for the health science professions as this increased interest may augment their chances of graduating from college with a science degree and entering the pipeline to science careers.⁸

The lack of a significant impact on self-efficacy for science or self-efficacy for science-related careers/occupations may be due to limitations in instrumentation, limitations in power, or limitations in intervention design or dosage. The marginal internal consistency of the self-efficacy for science subscale ($\alpha = .70$) raises concern about this measure due to the narrow range of the Likert scale (0-6) or the content of the items. Creative self-efficacy²³ might have been a more sensitive and appropriate measure for this study. Moreover, the decline for both groups in self-efficacy for science may relate to the phenomenon discussed by Bandura²⁴ where initially individuals have unrealistically high and not firmly established self-efficacy and then experience failures or complications in their performance that undermine their sense of efficacy. Thus, the intervention may have lacked sufficient mastery experiences to improve science self-efficacy, which have been found useful by others in intervening with middle school students.^{23, 25}

HEADS UP incorporates some of the strategies for science teaching recently suggested by the National Research Council, Committee on Science Learning.²⁶ The video stories show scientists interacting with students and each other and modeling scientific discourse and the development of scientific knowledge. In addition, students and teachers receive concrete examples that explain the science of diseases familiar to their families, such as diabetes and cardiovascular disease, and that show how a disease can affect more than one body system and how body systems work together. The HEADS UP science program may be further refined based on other recommendations of this Committee. Current efforts for disseminating HEADS UP include integration of Diabetes/Cardiovascular Disease and Nutrition/Physical Activity into a coordinated school health program for middle school, CATCH Middle School Program, under which approximately 500 middle school teams will have been trained by late fall of 2008. Further efforts for commercialization, dissemination, and training will be determined by project staff's experience with CATCH dissemination.²⁷

We believe the HEADS UP science program shows promise for reducing the achievement gap between white and non-Asian minority students by presenting minority health scientists as experts and role models. In addition, the HEADS UP program addresses instructional deficiencies in inner city schools by providing teachers with cutting-edge scientific content and resources prepared by health science experts. A multimedia curriculum design combining graphics, role-model stories, and hands-on activities that stress critical thinking and problem solving was chosen for HEADS UP to appeal to middle-school students. The modules are designed as a supplementary resource, meet state and national education standards, and can be easily and flexibly integrated into the existing curriculum to add interest for the students and professional development for teachers. We also believe the collaboration between teachers, curriculum specialists, media experts, and health scientists was a key factor in the success achieved in developing resources to engage these middle school students and foster their achievement in science.

HEADS UP is an innovative method for translating research findings into the community through middle-school science curricula. The HEADS UP program modules translate key research concepts on health issues such as diabetes, cardiovascular disease, and head injuries to teachers in the education community and to students and, through interaction with their children, to parents in the community at large.²⁸ In addition, the increased interest the students gain from the modules may ultimately lead to more non-Asian minority students entering the academic pipeline to careers in the health sciences. In summary, the HEADS UP program has, in an inner-city minority school, shown potential to improve minority

students' performance in science and interest in science. What is needed next is a larger sample of participating schools and teachers and a uniformly high implementation rate by teachers to validate the findings of this study and to substantively demonstrate the efficacy and effectiveness of HEADS UP-type programs.

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Table 1
Baseline Demographic Data and Stanford 10 Achievement Test Scores of the Intervention and Comparison Schools (2004–2005)

School	Enrollment	Free/Reduced Lunch (%)	Student Attendance (%)	Teacher Attendance (%)	Suspensions	Science Average NCE (6 th Gr)	Math Average NCE (6 th Gr)	Reading Ave NCE (6 th Gr.)
Intervention School	1100	96	95.2	95	1893	44	49	42
Comparison School	1200	96	96.8	95	1781	47	53	43

NCE, normal curve equivalents; Gr, grade

Table 2
Pre and Post-test Analysis of Stanford 10 Achievement Test NCE Scores (2004–2007)

Content Area	Group Size	Pre-Test 6 th grade	Pre-Test Std. Dev.	Post-Test 8 th grade	Post-Test Std. Dev.	Adjusted Post-Test Score *	F	P Value	Effect Size	Percentile Position
Science	HU=214	46.3	15.2	53.5	16.0	53.2	12.38**	0.001	0.23	59 th
	Comp=214	46.8	14.6	49.2	16.0	49.1				
Reading	HU=214	44.8	16.0	47.1	14.7	46.9	0.74	0.390	- 0.05	48 th
	Comp=214	44.2	16.0	47.4	15.1	47.6				
Math	HU=214	51.5	16.1	53.7	16.3	54.2	0.98	0.323	0.03	49 th
	Comp=214	52.7	15.6	53.8	16.5	53.3				

* Adjusted for pre-test. Matched on baseline free/reduced lunch status, gender, ethnicity, and fifth-grade science scores.

** Significance level: $P < 0.05$

NCE, normal curve equivalents; HU, HEADS UP; Comp, comparison

Table 3
Analysis of Occupational and Science Self-Efficacy Data (2004–2007)

Construct**	Group Size	Pre-Test Score	Pre-Test SD	Post-Test Score	Post-Test SD	Adjusted Post-Test*	F	P Value	Effect Size
1	HU= 199	3.7	1.13	3.86	0.97	3.89	11.08	0.001	0.32
	Comp= 199	3.9	1.20	3.58	1.17	3.55			
2	HU= 199	3.8	0.82	3.87	0.72	3.89	0.45	0.504	0.07
	Comp= 199	3.9	0.87	3.85	0.79	3.84			
3	HU= 199	3.7	0.69	3.72	0.55	3.73	2.68	0.103	0.15
	Comp= 199	3.8	0.72	3.66	0.65	3.64			
4	HU=214	3.2	1.15	2.85	1.16	2.81	0.25	0.617	-0.04
	Comp=214	3.0	1.06	2.83	1.11	2.86			

* Adjusted for pre-test. Matched on baseline free/reduced lunch status, gender, ethnicity, and fifth-grade science scores.

** Targeted Areas: 1=Interest in science; 2=Confidence in students' ability to perform well in science; 3=Fear of science; 4=Student self-efficacy for science-related careers/occupations

Table 4
Analysis of Subgroup's Stanford 10 Achievement Test NCE Scores (2004–2007) (High-implementing Teacher)

Content Area	Group Size	Pre-Test Score	Pre-Test SD	Post-Test Score	Post-Test SD	Adjusted Post-test Score [*]	F	P Value	Effect Size	Percentile Position
Science	HU=31	40.34	13.31	48.78	14.14	48.98	3.92	0.052	0.41	66
	Comp=31	40.93	12.52	43.00	15.93	42.80				
Reading	HU=31	40.36	15.11	42.43	10.58	42.83	0.04	0.842	0.03	51
	Comp=31	41.37	17.03	42.84	18.26	42.44				
Math	HU=31	43.87	10.58	49.19	13.77	53.72	19.09	0.001	0.70	76
	Comp=31	53.72	16.43	47.33	17.35	42.80				

* Adjusted for pre-test. Matched on baseline free/reduced lunch status, gender, ethnicity, and fifth grade science scores.
SD, standard deviation; HU, HEADS UP; Comp, comparison

Table 5
Analysis of Occupational and Science Self-efficacy Data (2004–2007): (High-implementing Teacher)

Targeted Area**	Group Size	Pre-Test Score	Pre-Test SD	Post-Test Score	Post-Test SD	Adjusted Post-test Score*	F	P Value	Effect Size
1	HU=29	3.56	1.12	4.04	0.92	4.07	8.33	0.006	0.72
	Comp=29	3.71	1.16	3.32	1.24	3.29			
2	HU=29	3.50	0.81	3.88	0.63	3.93	0.35	0.558	0.16
	Comp=29	3.78	0.73	3.87	0.77	3.82			
3	HU=29	3.53	0.76	3.77	0.57	3.83	4.25	0.044	0.43
	Comp=29	3.77	0.70	3.62	0.68	3.56			
4	HU=31	2.99	1.08	3.32	1.09	3.32	3.82	0.055	0.42
	Comp=31	2.98	1.19	2.84	1.20	2.84			

* Adjusted for pre-test. Matched on baseline free/reduced lunch status, gender, ethnicity, and 5th grade science scores.

** Targeted Areas: 1=Interest in science; 2=Confidence in students' ability to perform well in science; 3=Fear of science; 4=Student self-efficacy for science-related careers/occupations
SD, standard deviation; HU, HEADS UP; Comp, comparison