Scaling Up SimCalc Project

Middle School Students' Mathematics Learning: An Analysis of a Student Population in Texas

Technical Report 09 | August 2010

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Report Series Published by SRI International

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Acknowledgments

This report is based on work supported by the National Science Foundation under Grant No. 0437861. Any opinions, findings, and conclusions or recommendations expressed in this report are those of the authors and do not necessarily reflect the views of the National Science Foundation.

We thank G. Haertel, J. Knudsen, K. Rafanan, P. Vahey, S. Carriere, L. Gallagher, H. Javitz, T. Lara-Meloy, M. Robidoux, S. Empson, S. Hull, L. Hedges, S. Goldman, H. Becker, J. Sowder, G. Harel, P. Callahan, F. Sloane, B. Fishman, K. Maier, J. Earle, R. Schorr, and B. McNemar for their contributions to this research. We thank the participating teachers and Texas Educational Service Center leaders from regions 1, 6, 9, 10, 11, 13, 17 and 18; this project could not have happened without them. We thank and remember Jim Kaput, who pioneered SimCalc as part of his commitment to democratizing mathematics education.

Middle School Students' Mathematics Learning: An Analysis of a Student Population in Texas

We examined the population of students who participated in the seventh-grade year 1 randomized controlled experiment in Texas designed to test the effectiveness of SimCalc in improving student mathematics learning in middle school. This population consisted of approximately half Hispanic[1] and half non-Hispanic Caucasian students. Our analysis of the demographic data showed that, consistent with national and statewide Texas data, the Hispanic students in our study were primarily in schools that have a large population of low-SES students. Our analysis of assessment data showed that although the Hispanic students in this study had lower prior achievement, their learning gains were indistinguishable from those of the Caucasian students. On the basis of a set of detailed analyses designed to determine role of ethnicity and SES on prior achievement and learning gains, we conclude that the SimCalc program was effective for the diversity of students in our sample.

[1] We use the term Hispanic in this report because it is the term commonly used in Texas to designate people of Latin American—specifically Mexican—descent and thus was the term used in our instruments.

Introduction

Great concern has been raised about the so-called learning gap between Hispanic and non-Hispanic Caucasian students, especially between low-socioeconomic status (SES) Hispanic students and others (e.g., Gándara & Contreras, 2009). With a handful of exceptions, and despite the best intentions of educators and policymakers, meeting the needs of low-SES Hispanic students has proven elusive. Yet evidence from the Scaling Up SimCalc project indicates that SimCalc may provide equitable learning gains for both high-SES Caucasian students and low-SES Hispanic students.

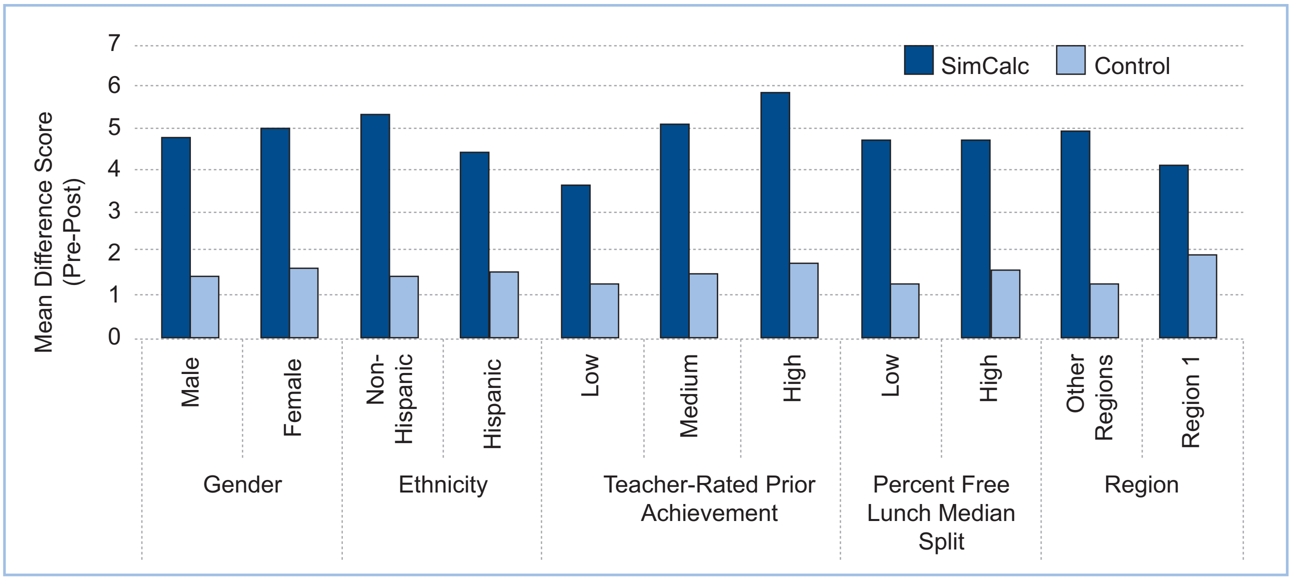
As described in earlier publications, students who learned proportionality using the SimCalc materials had significantly higher learning gains than students who learned proportionality with existing materials and methods (Roschelle et al., 2007). This finding was robust across demographic and geographic groups (Exhibit 1). Of particular interest was that Hispanic students in the SimCalc group had higher learning gains than Hispanic students in the control group.

We have analyzed the data further to better understand the characteristics of the Hispanic student population in the study and the effect of the SimCalc materials on these Hispanic students, particularly low-SES Hispanic students. Specifically, we addressed two questions:

1. Are there differential learning gains for classrooms with different percentages of Hispanic students?
2. Are there differential learning gains for classrooms with different numbers of low-SES students?

We did not find any interactions between student SES, prior learning, or ethnicity: The SimCalc materials appear to be consistently effective across the wide range of students and contexts in the study. Analyses of potential reasons for the effectiveness of SimCalc with a diverse student population are found in Vahey et al. (2010) and Roschelle et al. (2010).

Exhibit 1. Students using SimCalc had higher learning gains than students in control groups across a variety of demographic and geographic groups.



Data Sources

The Scaling Up SimCalc study comprised two experiments, seventh-grade year 1, and eighth grade, as well as a quasi-experiment in seventh-grade year 2. We analyzed data from one of these experiments, the seventh-grade year 1 study, because it had significantly more Hispanic students than the seventh-grade year 2 or the eighth-grade study. The reason for this discrepancy is that just before the second year of the seventh-grade experiment (which also corresponded with the first year of the eighth-grade experiment), the primarily Hispanic schools in the region along the Texas-Mexico border received a block grant of tens of millions of dollars to improve mathematics instruction. The requirements of the grant were such that almost all the education leaders, administrators, and teachers did not continue with our experiment (for details, see Tatar & Stroter, 2009).

To analyze differential learning gains, we synthesized data collected on individual students (student-level data), on the teachers in the study (teacher-level data), on the schools in the study (school-level data), and on the regional Education Service Centers (ESCs) and state (regional- and state-level data). For an explanation of the analysis methods and procedures for the Scaling Up SimCalc study, see Roschelle et al. (in press). As reported in Tatar and Stroter (2009), teachers throughout Texas were recruited for the Scaling Up SimCalc project. For each teacher, the research team randomly chose a target class to be the focus of study. By randomly choosing a target class, we ensured a representative range of student prior achievement while reducing the demands on the teacher and the research team of collecting and analyzing data for each class for each teacher. It is for those students in the target class that we report on student-level data. Through a process of iterative analysis and cross-checking we have determined the validity of our data across these different levels and are able to conclude that the SimCalc intervention was effective for the variety of students, teachers, and schools found in our population.

Student-Level Data

We collected three types of student-level data: SimCalc performance data, student demographic data, and teacher-reported student prior math achievement levels.

The SimCalc performance data consisted of student scores on SimCalc assessments (pretests and posttests). The assessment creation process was described by Shechtman et al. (2010). We asked teachers to fill out a roster for the target class, providing information about each student including gender, ethnicity, and prior math achievement level (low, medium, or high) and indicating whether the student was an English Language Learner (ELL). These data were collected before the SimCalc unit was implemented in the classroom.

Teacher-Level Data

For each teacher, the project team collected data on mathematical knowledge for teaching, demographics and educational background, and implementation of SimCalc (Roschelle et al., 2007; Shechtman, Haertel, Roschelle, Knudsen, & Singleton, 2010), and in the current analyses our team found no relevant interactions between the teacher data, student achievement, and student demographics.

The teacher-level data also consisted of student data aggregated across the entire target class. Because each teacher was assigned a target class for analysis, aggregating all student data for a teacher is equivalent to aggregating the student data across one class. As a result, our analysis treated classrooms and teachers equivalently, as each teacher's data were equivalent to the data from one classroom.

School-, Region-, and State-Level Data

Education data for the state of Texas, each region in Texas, and each school in Texas are available in the Texas Public Education Information Management System (PEIMS, (http://ritter.tea.state.tx.us/peims/), which is overseen by the Texas Education Agency (TEA). As stated on its website, PEIMS "encompasses all data requested and received by TEA about public education, including student demographic and academic performance, personnel, financial, and organizational information." For the purposes of this study, we used SES and ethnicity data about the state, regions, and schools, both to better understand the student contexts and to cross-check our teacher-reported data.

Data Cross-checking

We used a variety of datasets to cross-check the teacher-reported data. For instance, by comparing the PEIMS data on school populations with the teacher-reported data from the class roster, we determined how well the teacher-reported characteristics matched the official school data. For example, by using our own internal data on student pretests, we were able to cross-check teachers' classification of students' prior math achievement, and we found that teacher-reported prior math achievement accurately predicted student pretest scores. This finding held true across ethnicities, and we found no systematic bias in teacher perception of student math achievement (e.g., approximately the same percentage of Hispanic students from low-income communities was ranked as low, medium, or high prior achievement as Caucasian students from higher SES communities).

Similarly, we conducted cross-checks using district and state data. In the case of any significant mismatches, we further investigated to determine whether they were due to an error in our data-capture, teacher reporting, or significantly different characteristics in the teacher's target class than the school's overall student population. We found mismatches when comparing our student ethnicity data with Texas student ethnicity and when comparing teacher reports of English Language Learners (ELLs) with PEIMS data on ELLs.

Ethnicity

The student ethnicity data indicated that the students were primarily Hispanic and Caucasian, with very few African Americans or Asians/Pacific Islanders (Exhibit 2). Although the percentage of African American students was significantly lower in our study than in Texas overall, the ethnicity data reported by teachers closely aligned with the school-level data in PEIMS, as well as with school district data. Furthermore, no significant difference existed in the percentage of Caucasian and Hispanic students reported in the treatment and the control groups. On the basis of this cross-checking, the research team determined that the teacher report of ethnicity was accurate.[2]

Exhibit 2. Student Ethnicity in the SimCalc Study

Ethnicity	Percent
Hispanic	44.3
Caucasian	48.5
African American	4.2
Asian/Pacific Islander	1.5

2 Although our data were consistent with school and district data, they were not fully consistent with Texas State data: Texas has approximately 14% African American students, whereas our sample had only 4.2%. We found that our primary recruitment and professional development partners, the Education Service Centers (ESCs), did not have a significant reach into those districts with large numbers of African American students. More precisely, the ESCs did not have strong connections with most urban districts in Texas, and those districts have the largest population of African American students. As a result, our study has significantly fewer African American students than found within Texas. This does not present a threat to the study findings, but it does mean that we cannot generalize our findings to a primarily urban or African American student population.

English Language Learners

Our cross-check showed that the distribution of ELLs did not match that in many schools and districts. Some schools and districts that reported a student population with very few ELLs had teacher reports of majority-ELL classes. In some cases, the number of ELLs reported as being in a target class was actually higher than the number of ELLs in the school. Consequently, we determined that the ELL data collected in the study were not valid, and so we do not use them in our analyses.

To investigate why these data were not reported accurately, we analyzed the student rosters teachers submitted. We believe that teachers experienced difficulty in reading or understanding this entry on the student roster: The roster had the text "English Language Learners" printed vertically at the top of a long form. Teachers may have misread this, perhaps even interpreting a check in this column to mean that the student was a native English speaker or that the student was enrolled in English classes. In retrospect, listing the acronyms commonly used in Texas to denote English Language Learners (ELL, LEP, and ESOL) might have been more productive.

The Student Population

The Hispanic students in this study were demographically similar to Hispanic students throughout the state of Texas and demographically similar to Hispanic students throughout the United States as a whole. That is, they are predominantly low SES, are segregated into primarily Hispanic and low-SES schools, and have lower prior mathematics achievement than their Caucasian counterparts. As we will see in the Student Learning section, however, their learning gains were statistically indistinguishable from those of the Caucasian students in the study.

In the year 1 seventh-grade study, 796 students were in the SimCalc condition. There is incomplete data for gender, ethnicity, and student prior achievement ratings, based on the data teachers reported in the student rosters (see Exhibit 3). As a result, the astute reader will notice different ns in our tables, based on the variation in roster completion.

Exhibit 3. Students for Whom Teacher-Reported Data Are Available

Teacher Report Data Points	*N*	% Complete
Total Students	796	100
Gender	750	94
Ethnicity	736	92
Student prior achievement rating	693	87
Combined ethnicity/prior achievement rating	685	86

Geographical Distribution of Students

With only minor differences, the geographical distribution of Hispanic students in the study was similar to that in the regions as a whole (Exhibit 4). Most of the Hispanic students were in three regions: Region 1, the southeast region of Texas that borders Mexico and is one of the poorest areas in the country; Region 13, the primarily urban area around Austin; and Region 18, the primarily rural region around Midland. Whereas Region 1 is almost entirely Hispanic and has more Hispanic students than any other region, almost 60% of the Hispanic students in the study are from regions other than Region 1.

Exhibit 4. Distribution of Hispanic Students Across Regions

Region	Region Name	Hispanic Students per Region (%)	Hispanic SimCalc Students (%)	Total SimCalc Students	Total Hispanic SimCalc Students
1	**Edinburg**	**96**	**96**	**137**	**132**
6	Huntsville	22	8	13	1
9	Wichita Falls	18	22	46	10
10	Dallas	36	13	72	9
11	Fort Worth	26	11	70	8
13	**Austin**	**38**	**37**	**199**	**74**
17	Lubbock	50	44	9	4
18	**Midland**	**56**	**46**	**190**	**87**
Total				736	325

Classroom Distribution of Students

To highlight the contrast of the percentage of Hispanic students across classrooms, we created a split using a data-driven approach rather than a true tertile split. That is, to create the splits, a histogram was used to identify natural gaps in the distribution of percentages of Hispanic students across the classrooms (see Exhibit 5). The distribution of Hispanic students in a classroom was split into three groups: Few Hispanic (0–25%), Mixed Hispanic (26–69%), and Mostly Hispanic (70–100%); no classes had between 66% and 80% Hispanic students. The split resulted in the school, teacher and percentage of Hispanic students in classroom breakdown shown in Exhibit 6.

Exhibit 5. Distribution of Hispanic Students per Classroom

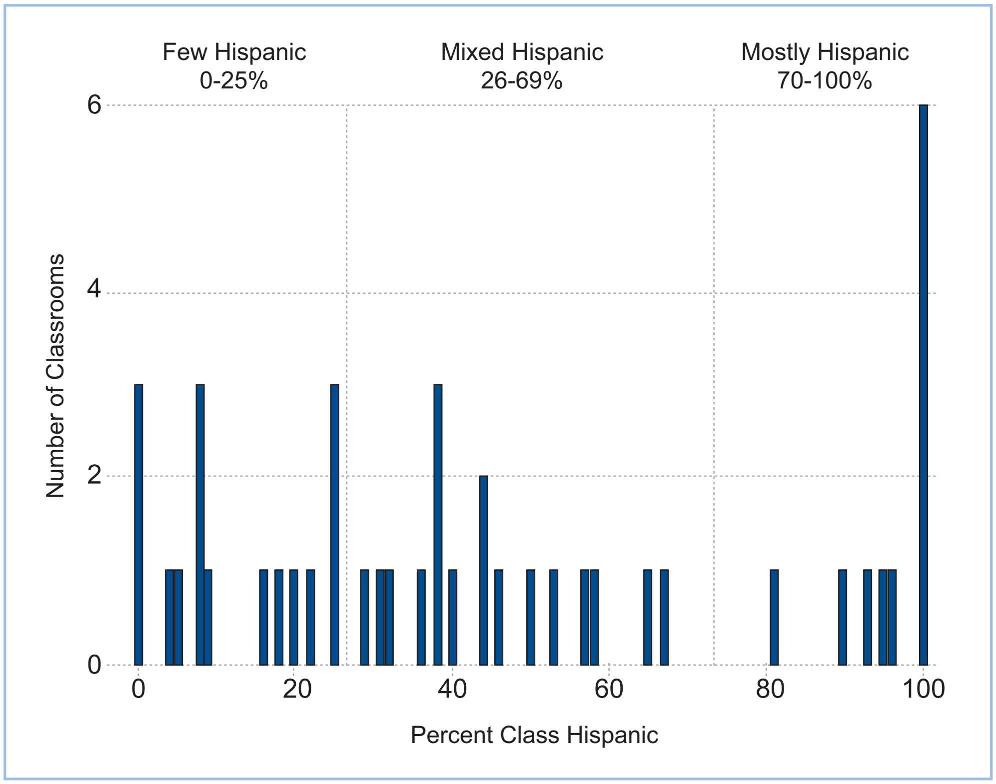


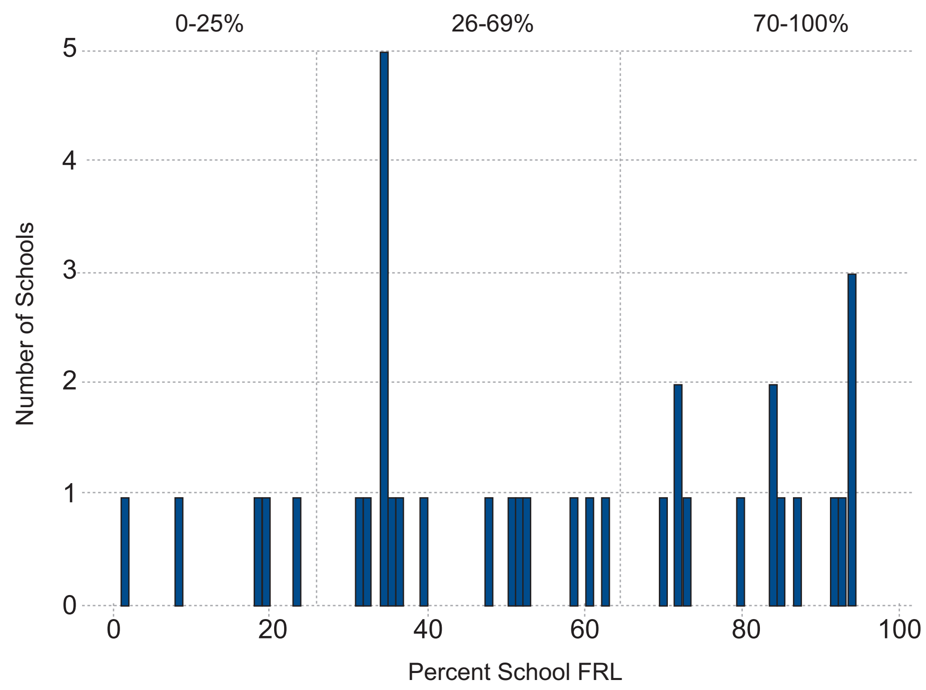
Exhibit 6. Schools, Classrooms, and Hispanic Students Within Each Hispanic Mix Classroom Category

Hispanic Mix Category	Hispanic Students per Classroom (%)	Schools *(N)*	Classrooms *(N)*	Hispanic SimCalc Students (%)	Hispanic SimCalc Students (N)	SimCalc Students Overall *(N)*
Few Hispanic	0–25	12	16	11.07	31	280
Mixed Hispanic	26–69	14	17	44.00	121	275
Mostly Hispanic	**70–100**	**8**	**11**	**95.58**	**173**	**181**
Total		34	44		325	736

Socioeconomic Status Distribution of Students

The percentage of students receiving free or reduced-price lunch (FRL) at a school is an indicator of SES; schools with higher percentages of FRL students are schools with lower SES. Because we did not have individual FRL data for each student, we used the PEIMS school-level data as an indicator of the general school SES (not the student or classroom SES).

Exhibit 7. Distribution of SimCalc Classrooms in Schools With Different Percentages of Students Receiving FRL



As with the distribution of Hispanic students, to highlight the contrast between the percentages of students receiving FRL, the split was created using a data-driven approach rather than a true tertile split (Exhibit 7). The groups are Low FRL (0–25%), Medium FRL (26–69%), and High FRL (70–100%).

Exhibit 8 shows the number of schools, teachers, and students in each FRL category. The proportion of Hispanic SimCalc students in each FRL category deviated dramatically from the overall percent of Hispanic students in the study. If Hispanic students were equally distributed, we would find approximately 44% Hispanic students in each FRL category. Instead, the percent Hispanic students ranged from 4.6% in the Low FRL category to 83.9% in the High FRL category. The data in Exhibits 8 – 10 are consistent with other regional and national findings that Hispanics are segregated ethnically (in majority-minority schools) and socioeconomically (in schools with more than 75% FRL) (Gándara & Contreras, 2009; Orfield & Lee 2006; U.S. Department of Education, NCES 2007).

Exhibit 8. Schools, Classrooms, and Hispanic Students Within Each FRL Category

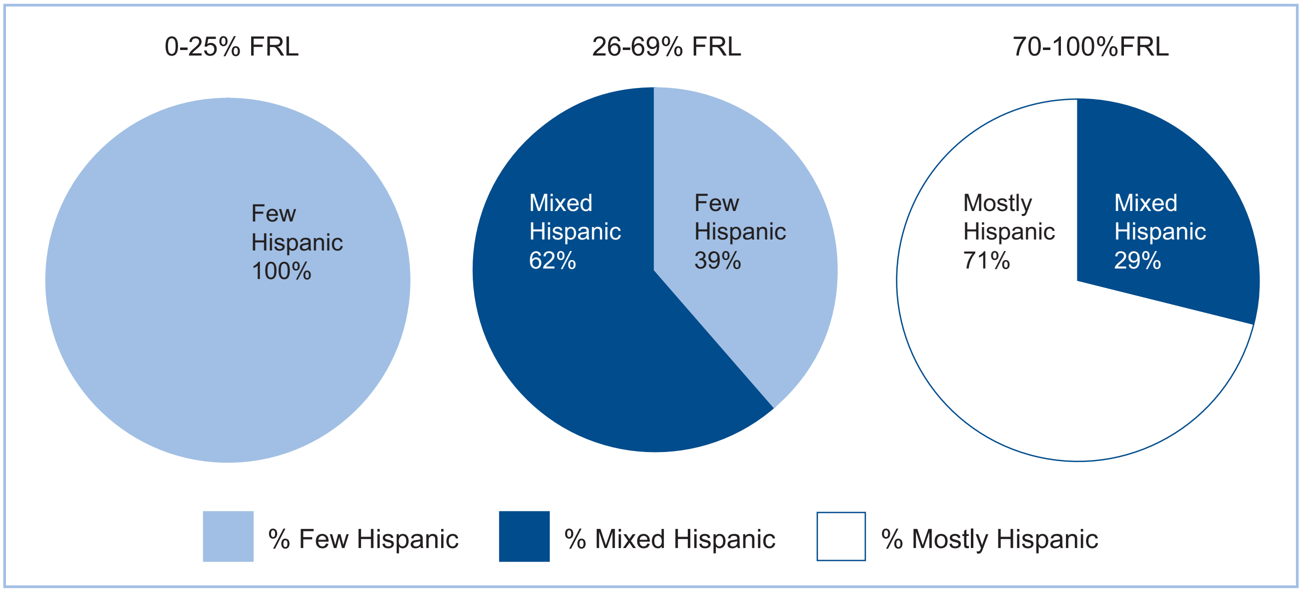
FRL Category	FRL Schools (%)	Schools *(N)*	Classrooms *(N)*	SimCalc Students Overall *(N)*	SimCalc Hispanic Students *(N)*	SimCalc Hispanic Students (%)	Percent SimCalc Hispanic students
Low	0–25	4	7	152	7	4.61	4.61
Medium	26–69	16	20	329	104	31.61	31.61
High	**70–100**	**14**	**17**	**255**	**214**	**83.92**	**83.92**
Total		34	44	736	325		

In a further analysis of the distribution of Hispanic students compared with the distribution of FRL, we found that no classrooms with few Hispanic students (0–25%) were in schools with a high percentage of FRL students (70–100%) (Exhibit 9). Conversely, no classrooms that were mostly Hispanic (70% or more) or mixed Hispanic (26–69%) were in schools with a low percentage of FRL students (0–25%). This indicates that, as is found in the general population, Hispanic students in our study were primarily segregated into low-SES schools. As the percentage of FRL students increased, so did the percentage of Hispanic students in a school (Exhibit 9 and Exhibit 10).

Exhibit 9. Number of Schools, Teachers and Students by Hispanic Mix Category and Percent FRL Category

	% School FRL			
Hispanic Mix Category	0–25	26–69	70–100	Total
Few Hispanic 0-25%				
N Teachers	7	9	0	16
N Schools	4	8	0	12
N Students	152	128	0	280
Mixed Hispanic (26–69%)				
N Teachers	0	11	6	17
N Schools	0	8	6	14
N Students	0	201	74	275
Mostly Hispanic (70–100%)				
N Teachers	0	0	11	11
N Schools	0	0	8	8
N Students	0	0	181	186
Total Teachers	7	21	16	**44**
Total Schools	4	17	13	**34**

Exhibit 10. Few, mixed, mostly Hispanic students in percent school FRL

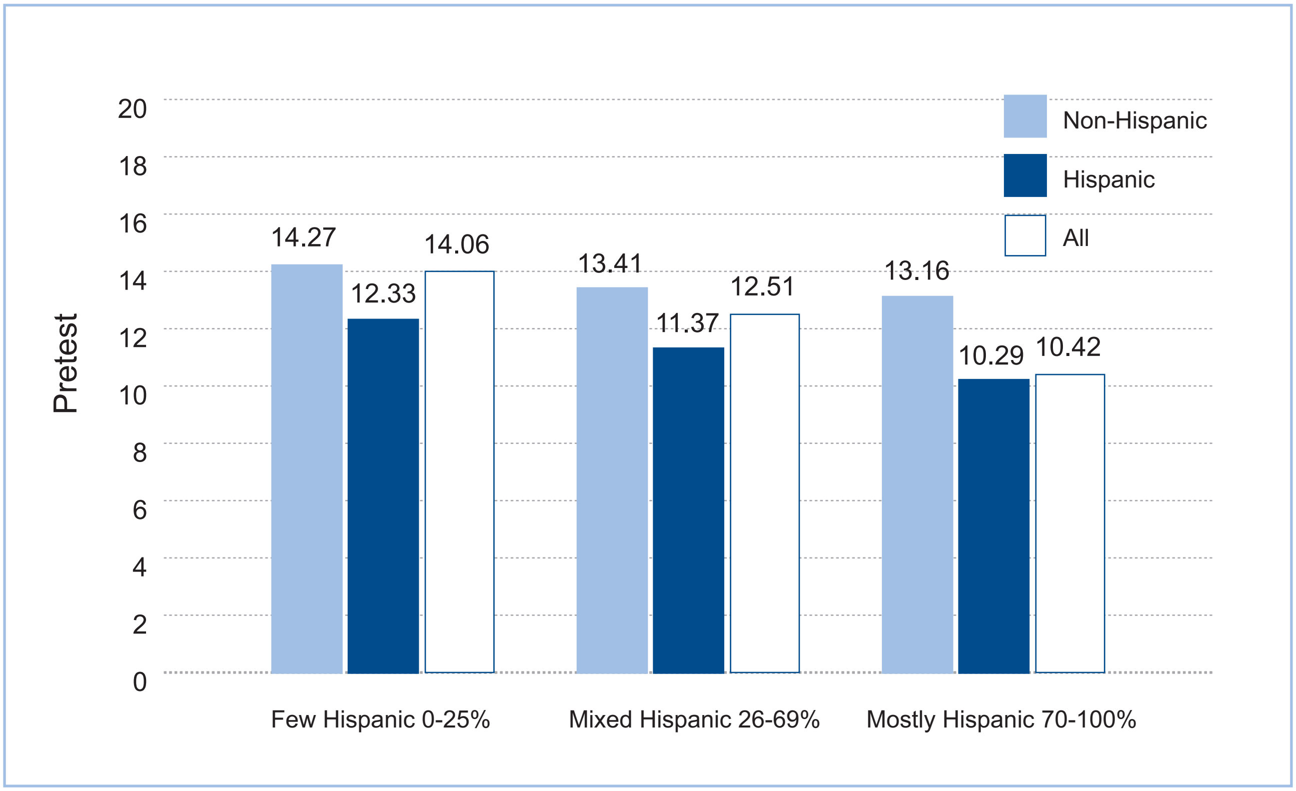


Prior Mathematics Knowledge

Examining SimCalc pretest scores for Hispanic and non-Hispanic students, categorized by percentage Hispanic classrooms, we see that in all three categories Hispanic students scored lower than non-Hispanic students; in the Mixed and Mostly Hispanic categories, this difference was statistically significant (Exhibit 11).

These data are consistent with national and Texas trends of Hispanic students scoring below Caucasian students on tests of proficiency in math (NAEP scores for fourth- and eighth-grade mathematical achievement by ethnicity as cited in Gándara & Contreras, 2009; see also http://ritter.tea.state.tx.us/perfreport/aeis/).

Exhibit 11. Student Pretest Scores by Hispanic Mix Category



	Non-Hispanic		Hispanic		All	
Hispanic Mix Category	Pretest Score	*N*	Pretest Score	*N*	Pretest Score	*N*
Few Hispanic (0–25%)	14.27	249	12.33	31	14.06*	280
Mixed Hispanic (26–69%)	13.41**	154	11.37**	121	12.51*	275
Mostly Hispanic (70–100%)	13.16*	8	10.29*	173	10.42*	181
Total		411		325		736

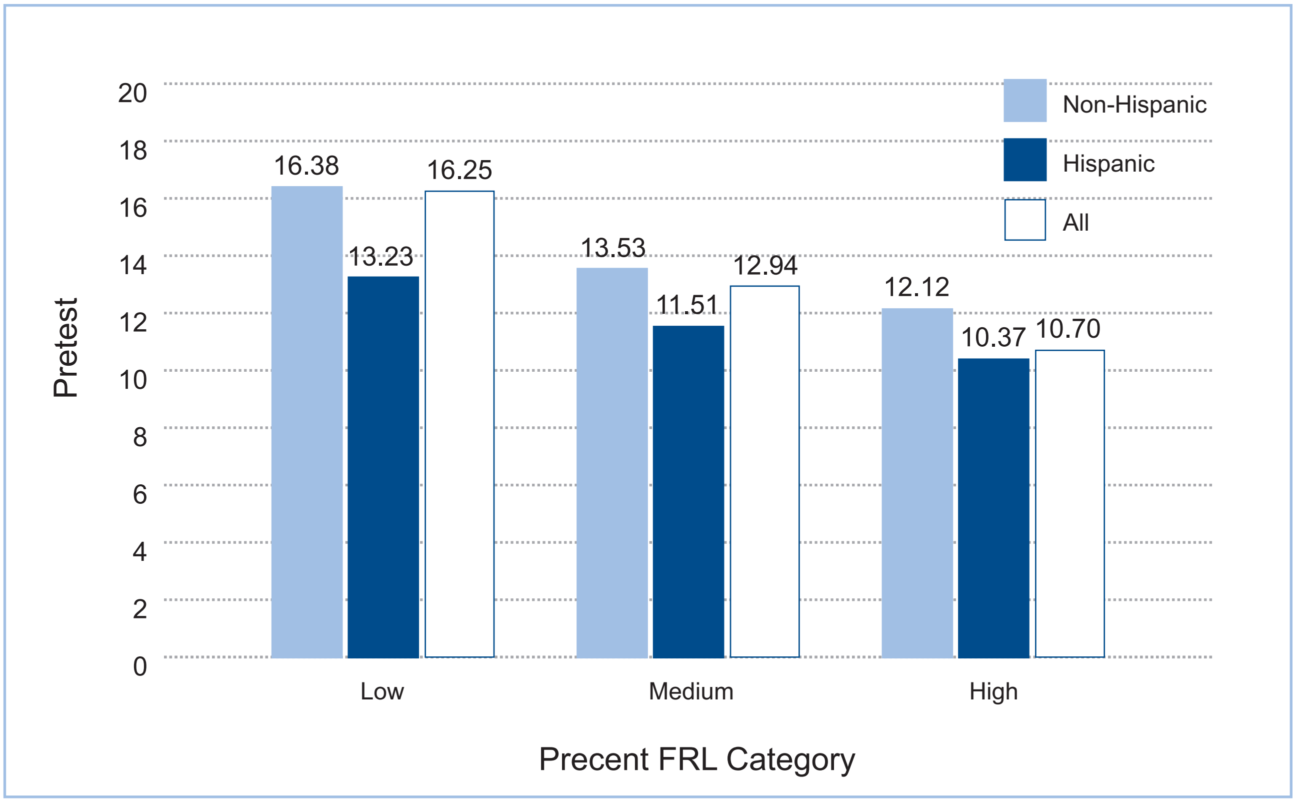
* p<.05; ** p <.00

The difference between non-Hispanic and Hispanic students is significant in the Mixed (13.41, 11.37) and Mostly Hispanic (13.16, 10.29) classrooms.

In addition, there was a significant trend that schools with a higher percentage of students receiving FRL had lower pretest scores (Exhibit 12), a finding that is consistent with statewide and nationwide data (Barton, 2003). The difference between pretest scores for non-Hispanic and Hispanic students for each of the three FRL categories was significant. There was also a significant difference in pretest scores between the FRL categories for non-Hispanic students (x^2, 6.61, $p < .05$). Students overall in low-SES schools underperformed on the pretest compared with those in high-SES schools, and Hispanics in low-SES schools underperformed on the pretest compared with other students in low-SES schools.

Our results indicate that Hispanic students in our study, consistent with other reports, were primarily relegated to low-SES schools and had lower prior mathematical achievement according to the SimCalc pretest measure. Because most Hispanic students were segregated in low-SES schools, we cannot separate the influence of ethnicity and SES. In the next section, we investigate the learning gains of Hispanic students across different SES levels and compare the gains with those of Caucasian students across different SES levels.

Exhibit 12. Pretest Scores by Hispanic Mix Category and FRL for Non-Hispanic, Hispanic, and All Students



	Non-Hispanic		Hispanic		All	
FRL Category	Pretest Score	*N*	Pretest Score	*N*	Pretest Score	*N*
Low (0–25%)	16.38**	145	13.23**	7	16.25*	152
Medium (26–69%)	13.53**	225	11.51**	104	12.94*	329
High (70–100%)	12.12*	41	10.37*	214	10.70*	255
Total		411		325		736

Findings: Student Learning

We wanted to see whether SES or ethnicity has a differential effect on students' learning gains with SimCalc. The primary analysis had indicated that Hispanic students scored lower on the pretest than non-Hispanic – mostly Caucasian – students but that average gain scores were comparable for Hispanic and Caucasian students (Exhibit 13).

To probe the data further, we asked whether Hispanic students in classrooms with different ethnicity and SES mixes fared differently (Research Question 1). Significant differences could mean that the SimCalc materials have differential effects based on these contextual variables. We found no significant differences in learning gains that can be attributed to these contextual differences, providing evidence that the learning gain from using SimCalc materials is robust across the wide variety of contexts in the study.

Although Hispanic students in predominately non-Hispanic classrooms gained about 1 point more than the non-Hispanic students (Exhibit 14), this difference was not significant (learning gain of 7.0 points compared with 5.9 points). In mixed classrooms, Hispanic students had non-significant learning gains slightly less than those of the non-Hispanic students (5.9 points compared with 6.4 points). Hispanic students in mostly Hispanic classes had non-significant learning gains slightly greater than non-Hispanic students in those classrooms (5.6 points compared with 5.0 points). Therefore, whereas ethnicity segregation is related to the mathematical knowledge Hispanic students demonstrated on the pretest (Exhibit 13), it does not seem to be related to gain scores.

Exhibit 13. Hispanic students started lower but had similar learning gains to those of Caucasian students.

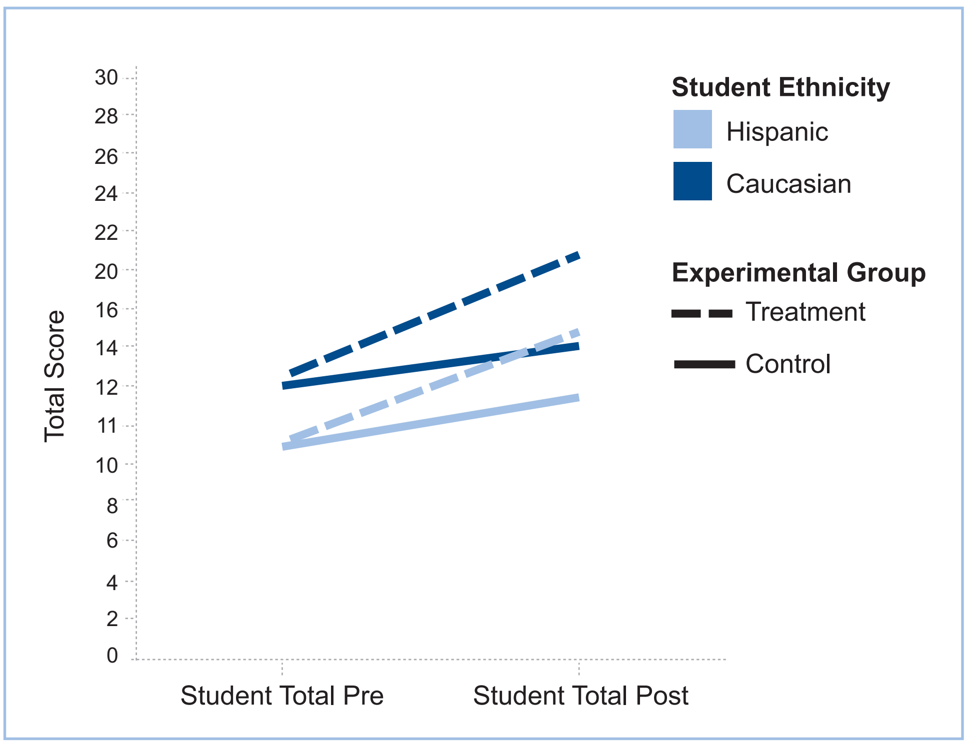
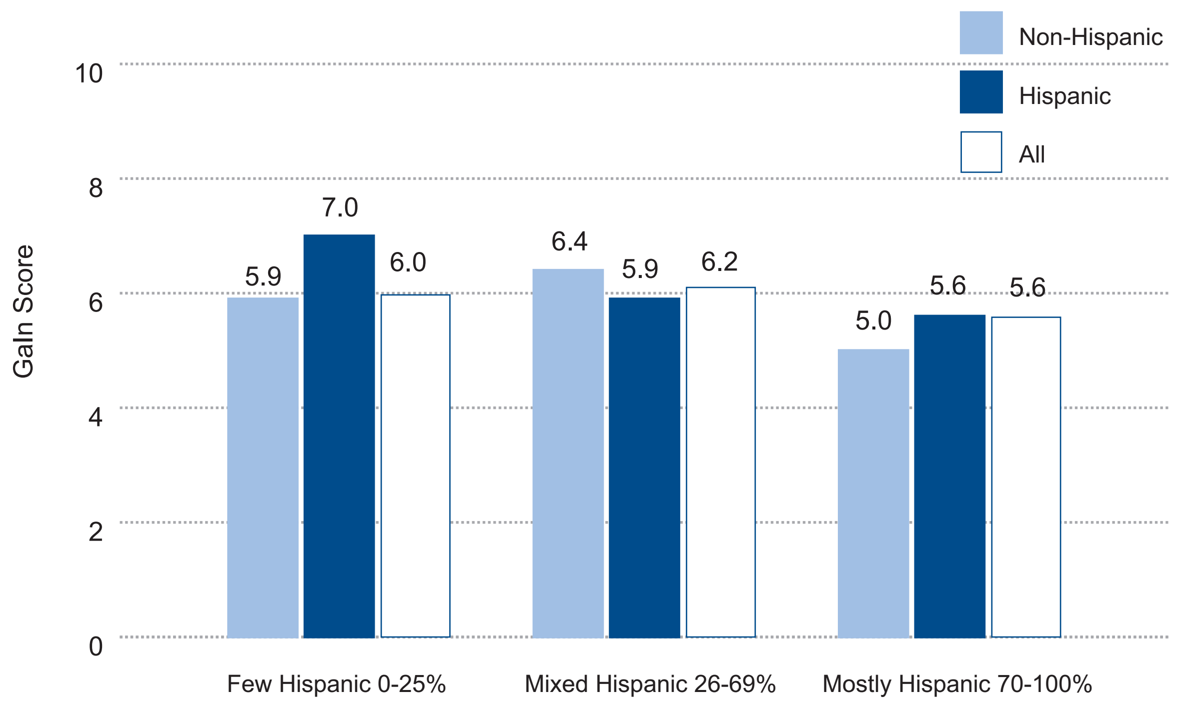


Exhibit 14. Student Gains by Hispanic Mix Category*

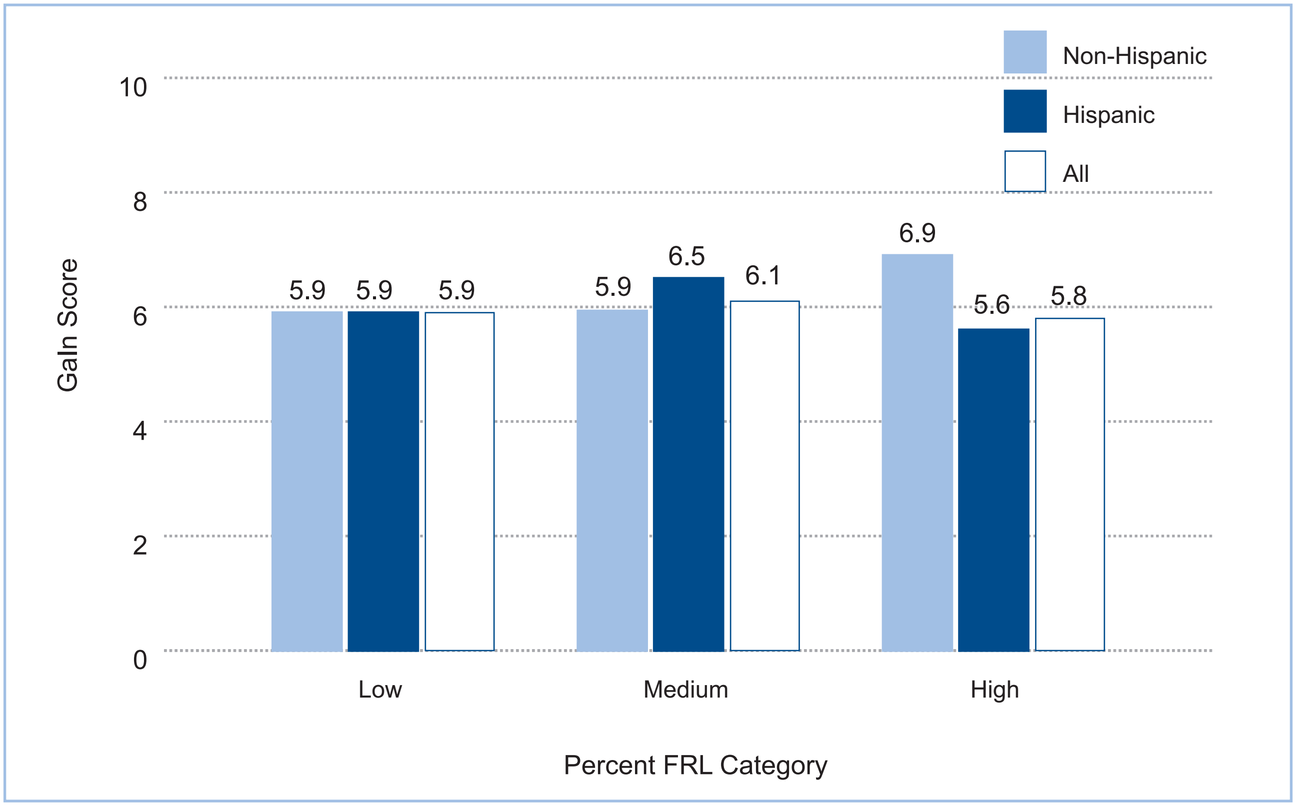


	Non-Hispanic		Hispanic		All	
Hispanic Mix Category	Points Gained	*N*	Points Gained	*N*	Points Gained	*N*
Few Hispanic (0–25%)	5.9	249	7.0	31	6.0	280
Mixed Hispanic (26–69%)	6.4	154	5.9	121	6.2	275
Mostly Hispanic (70–100%)	5.0	8	5.6	173	5.6	181
Total		411		325		736

* None of the differences in gain scores are statistically significant.

Our second research question asked whether there were differential learning gains for classrooms with different numbers of low-SES students. What we found is that although there were significant differences in pretest scores between Hispanic and non-Hispanic students by SES, there were no significant differences in gain scores (Exhibit 15).

Exhibit 15. Gain scores by Hispanic Mix Category and FRL for Non-Hispanic, Hispanic, and All Students



	Non-Hispanic		Hispanic		All	
FRL Category	Gain Score	*N*	Gain Score	*N*	Gain Score	*N*
Low (0–25%)	5.9	145	5.9	7	5.9	152
Medium (26–69%)	5.9	225	6.5	104	6.1	329
High (70–100%)	6.9	41	5.6	214	5.8	255
Total		411		325		736

Conclusions

We started this report by asking whether the learning gains of the Hispanic students in the SimCalc condition could be attributed to demographic and socio-economic variables. These analyses provide evidence that the SimCalc materials were equally effective for Hispanic and Caucasian students, regardless of SES. This result is of particular importance because low-SES Hispanic students have been underserved by existing educational materials.

The Hispanic population in the study was distributed in ways that mirror national trends and that have been described by other researchers. The majority of the Hispanic students in the Scaling Up SimCalc study were segregated to schools that are majority minority and that have a high percentage of students receiving free and reduced-price lunch. Although the mean of Hispanic students scored lower on the pretest, their learning gains were similar to those of other subgroups. Ongoing analyses are being conducted to determine precisely what aspects of the SimCalc materials may have led to this robustness.

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Sponsor: The National Science Foundation, Grant REC - 0437861

Prime Grantee: SRI International. Center for Technology in Learning

Subgrantees: Virginia Polytechnic Institute and State University; University of Massachusetts, Dartmouth; The University of Texas at Austin; and The Charles A. Dana Center at The University of Texas at Austin

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