Scaling Up SimCalc Project

Recruitment Strategies, Outcomes, and Implications for a Randomized Controlled Experiment with Teachers

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Recruitment Strategies, Outcomes, and Implications for a Randomized Controlled Experiment with Teachers

In this report, we examine recruitment of teachers for three randomized controlled experiments in Texas designed to test the effectiveness of SimCalc in improving student mathematics learning in middle school. Our recruitment sample and retention rates suggest that we did recruit and retain a wide variety of participants into the study, despite several forces working against variety. Nonetheless, some identifiable groups, such as African Americans, were not well represented. We discuss recruitment and retention as a tension between the pragmatic conduct of the experiments and the ideal from a scientific perspective.

Introduction

In the context of hiring, recruitment has been described as the process of seeking out and luring qualified candidates to apply for available positions (Cawthon, 2006). In standard psychology experiments, recruitment is often accomplished by making participation a course requirement for undergraduate students. In health-related experiments, recruitment is often accomplished by explaining the potential benefit to a group of people who have a disease. The case of education is different. The benefits of an experiment to the students may be substantial, and those benefits might in general be strong incentives for the teacher to participate. But teachers are typically bombarded with requests, demands, and promises from many sources with respect to change, experimental and otherwise. At the time of recruitment, the teacher does not know whether the proposed intervention is particularly promising. Moreover, teachers may experience considerable inconvenience through participation and little personal reward. Thus, recruiting teachers can be unusually difficult in school-based research.

Further, the recruitment of willing, eligible, and desirable research participants has serious implications for interpreting data, characterizing the population to which results most immediately apply, and generalizing beyond the participants (Shaddish, Cook, & Campbell, 2002). Researchers, scholars, educators, politicians, sociologists, and school administrators have reported at length on the methods and results of school-based research studies, but less has been written on the implications and complications of recruiting teachers, schools, and students into these studies (Testa & Coleman, 2006). Thus, the need exists to review and revise recruitment strategies so that the implications of recruitment for generalization from a sample to a broader population are better understood (Anaya & Cole, 2001; Bennett, Cole, & Thompson, 2000; Jones, Castellanos, & Cole, 2002; Pascarella & Terenzini, 1991). Just as there is no single best experimental design for all investigations, there is no one-size-fits-all recruitment strategy. Accordingly, it is useful to explore how recruitment plays out in particular studies and circumstances.

This report describes the recruitment, retention, and sample characteristics in a large-scale randomized controlled study of scaling up SimCalc in Texas

(Roschelle et al., 2007a; Roschelle et al., 2007b; Tatar et al., 2008). The project as a whole examined the effectiveness of SimCalc, an intervention consisting of a novel curriculum, technology, and teacher professional development to improve student math learning (Roschelle, Kaput, & Stroup, 2000). Within that overall purpose, we have focused on contributing to needed knowledge about recruitment and retention of teachers in large-scale studies. A paper on the pilot experiment addressed the implications and clarifications associated with the recruitment of a "wide variety" of teachers and the use of background data to inform both external and internal validity (Tatar, Ravitz, & Stroter, 2008). In this technical report, we took data from three studies—the pilot study, the seventh-grade experiment, and the eighth-grade experiment—to examine the relationship between recruitment, sample, and validity. Additionally, because the seventh-grade experiment continued for a second year, we examined persistence of teachers in the experiment from Year 1 to Year 2.

Most of the data about the teachers, schools, and comparison groups discussed here were drawn from self-reported demographics and from the Texas Public Education Information Management System (PEIMS) datasets. PEIMS reports the results of a complete census of teachers, schools, and districts conducted yearly, allowing us to characterize bias in the samples.

This report begins with a discussion of the relationship between recruitment and validity. We then give an overview of the Scaling Up SimCalc project, followed by examination of three aspects of the studies that relate to recruitment and retention: (1) the recruitment strategies used to gain participants, (2) the properties and characteristics of our sample as a result of recruitment efforts, and (3) the implications of the relationship between our recruitment strategy and research outcomes, including external validity.

Recruitment and Validity Concerns

The purpose of a study, experimental or otherwise, is to investigate a phenomenon and usually to draw causal inferences about it. To draw causal inferences with confidence, we must rule out other explanations of apparent relationships in the data. In the SimCalc project, the nature of the sample studied is crucial to ruling out explanations that have to do with properties of the participants and settings instead of properties of the different experimental conditions.

In general, random sampling from a population provides the strongest evidence for the claim that findings generalize from the sample studied to an entire population of relevant parties (Shadish, Cook & Campbell, 2002). However, random sampling is rare and difficult under many circumstances, especially in studies of public schools (Cawthon, 2006) and may not even lead to the desired outcome if the response rate from the people who are approached is too low or if the resulting population is hard to characterize in meaningful ways.

Instead of sampling randomly, it is customary to collaborate with professional and social networks in recruiting. This involves both direct and indirect communication with organizations and individuals who can refer potential participants. Testa and Coleman (2006) suggested three key components to the recruiting of schools, teachers, and students for large-scale research studies: (1) the use of appropriate research tools, (2) selecting and contacting participants, and (3) the importance of fieldworkers. This list, however, seems to concern focus on the pragmatics of obtaining enough participants rather than the representativeness of the sample.

In the current project, we had both a control group and randomized assignment to condition (by school). These factors reduced threats to validity considerably, giving us confidence in the causal relationships within our data. A number of threats to the causal claim remain, however. A concern with external validity, that is, "estimates of the extent to which a causal relationship holds over variations in persons, settings, treatments and outcomes" (Shadish, Cook, & Campbell, 2002, p. 86), raises the possibility that the results may not generalize to other kinds of people or settings. A concern with internal validity, that is, reasons to believe that the intervention caused the learning outcome rather than some other factor, raises the possibility that despite randomization, some characteristic of the population or setting may have led to the positive outcomes in the treatment condition compared with the control. Differential attrition between conditions could be one such difference. An additional concern related to recruitment and retention is that difference in response between treatment and control might be caused by an unintended interaction between some aspect of the population and the treatment. Thus, if the entire sample consists of mathematics teachers who like to try new things and the intervention but not the control allows them to do that, the experimental condition may contribute to the overall effect simply because it is new, not because of its content.

These are general concerns. The question is how they play out in these the Scaling Up SimCalc studies.

Scaling Up SimCalc Project

The Scaling Up SimCalc project comprised a pilot study, a seventh-grade experiment, and an eighth-grade experiment on the efficacy of a combination of SimCalc technology, associated curriculum, and teacher professional development in comparison. In each case, the experiments consisted of a simple contrast of a treatment and a control condition, as described in previous technical reports about the project (Roschelle et al., 2007a, 2007b), as well a journal article about the pilot study (Tatar et al., 2008).

In the seventh- and eighth-grade treatment conditions, the curriculum and SimCalc exercises differed; the curriculum in each year addressed learning goals appropriate for that year. We also used a different kind of control. In the seventh-grade experiment, the control was a very high quality teacher professional development workshop on the same kind of pedagogy about rate and proportionality as in the SimCalc intervention. Teachers in both control and treatment conditions took the workshop, with treatment teachers having additional instruction on the technology and particular curriculum they were to teach. In the eighth-grade experiment, the control was a high-quality mathematics workshop about statistics (not the mathematics of change and variation) that was equated for time with the treatment workshop. In all the experiments, however, the treatment teachers had an additional 1-day planning meeting in the fall, so the equation between conditions was not perfect relative to time and attention.

SimCalc technology and the associated curricula are aimed at allowing students to engage in active exploration of the mathematics of change and variation. This is a strand of learning that runs throughout K–12 education, culminating for most students in algebra and for a few in calculus. In the seventh grade in Texas, rate and proportionality are key topics related to change and variation. In the eighth grade in Texas, linear functions are key topics. Much of the validity of the experiment rests on the strength of the constructs used to measure learning in these areas. Additional issues about validity arise in relationship to the statistics used to analyze the data.

Mathematics learning across all three experiments was characterized by very strong evidence of growth, featuring student-level effect sizes of 0.86 (pilot), 0.63 (seventh grade Year 1), and 0.56 (eighth grade). Learning was also characterized by variation across different classrooms, so that out of the 30 problems on the seventh-grade test, one treatment classroom showed an average gain of only 2 while another gained as much as 11 points.

Although the major point of the research was to establish and replicate the main effect, we were also interested in understanding the sources and meaning of variation. Internal analyses conducted by region of Texas in the first year of the seventh-grade experiment and in the eighth-grade experiment consistently reaffirmed the pattern of the main result.

Whereas constancy across the samples is highly desirable in a recruiting process, variation from experiment to experiment may be more desirable in a research program because it helps to establish that the phenomenon is robust under variations in participants.

Recruitment Strategies Put into Practice

The pilot study and the seventh-grade and eighth-grade experiments had similar but not identical recruiting techniques. In all, the recruiting occurred in the spring of one school year, the training over the summer, and the other project elements at some point during the next school year. In all cases, permission and some degree of participation were required not only of the teachers, but also of the local and district administration and of the students and parents in the teachers' randomly chosen target classes. The pilot involved considerably more upfront commitment both in terms of the length of the application and the travel associated with participation than the other two. The seventh-grade experiment was (at least in theory) more structured and systematic in the approach to recruiting and featured a control that was tightly related in curricular content to the treatment condition. In the eighth-grade experiment, the control was similar to the treatment in that it involved technology but it differed in the kind of mathematics presented.

The recruitment strategies used in each experiment also had some potentially important differences. Because the PEIMS dataset includes contact information for teachers, we had thought that we would be able to contact teachers individually by mail to invite them to apply. In the course of applying, they would gain permission from their principals and districts, possibly with our help. However, because teachers are a protected class of participants, the Institutional Review Board (IRB) at one of the participating institutions requested that we not approach teachers directly. The IRB initially required that we have prior permission from the district and the principal or mathematics coordinator. We fully support the need to protect teachers' rights as professionals, but we were concerned that these requirements may have caused us to unintentionally exclude from pilot study recruitment teachers who might have chosen to participate but who never were notified about it and could not use their on-the-ground information to persuade the administration to allow participation. Instead, in the recruitment we had to rely on the initial decisions of administrators who presumably varied in their decisiveness, their openness to novelty, and whatever prior conceptions they had about mathematics education, possibly in the absence of experience in the mathematics classroom.

In the seventh- and eighth-grade experiments, we gained permission to contract with the leaders of the Education Service Centers (ESCs) in Texas to help with recruitment. Texas is divided into 20 ESCs that deliver mathematics and science teacher professional development, so the ESC leaders have regular contact with many teachers and administrators in the schools. The IRB allowed them to recruit teachers and schools for the experiments in the course of their contacts with districts. They were also allowed to obtain written consent from the districts for teachers' participation. In using ESC leaders, we were building on existing social networks. However, some districts tend not to use ESC services for teacher professional development. Of the approximately 1,027 districts in Texas, about 11 may be considered large urban districts, and they tend to provide their own teacher professional development services and practices and do not rely on the regional ESCs.

Our partners at the Charles C. Dana Center at the University of Texas at Austin facilitated recruitment for all experiments. The Dana Center works closely with school administrators, mathematics coordinators, and ESC personnel to improve teaching and learning. The center was founded in 1993 to create programs that support Texas students, especially ethnic minority and rural students, in achieving at the highest academic levels and in pursuing advanced degrees in mathematics-based fields. In the late 1990s, the Dana Center helped coordinate the development of the mathematics and science Texas Essential Knowledge and Skills (TEKS) standards, which articulate what more than 4 million Texas children must know and be able to do in these academic subjects. The Dana Center reinforced this work by collaborating with school districts and community-based organizations to increase educational access for all Texas students, especially those challenged by poverty. By virtue of these activities, the Dana Center has a presence in hundreds of Texas schools and in virtually every county across the state. The center works closely with the ESCs mathematics coordinators, providing them with teacher professional development workshops. The Dana Center had high credibility with target participants, which most likely enhanced their willingness to consider participating in the studies.

Pilot Study Recruitment

Recruitment of the teachers for the pilot study was through mass e-mails to districts and schools from the Dana Center. Dana Center personnel also mentioned the project in talks at meetings of associations of district administrators and mathematics coordinators. The Dana Center staff sought permission from districts throughout the state to approach their teachers. Once permission was obtained, the plan was to send a flyer to teachers about the project through e-mail and postal mail. However, several districts responded with an actual list of teachers whom they had approached rather than with permission for us to approach teachers.

The goal was to invite about 30 teachers to the workshop, but we received fewer than 30 applications so all 25 applicants were invited to participate. The application for the pilot was quite long, and participation required three trips to Austin in the first year. Although these trips were paid for by the project, the travel may have been a barrier to participation. Still, our small pool did include four teachers from the El Paso district, who opted to drive the 8–9 hours each way from El Paso to Austin to participate in the summer workshop and planning weekend.

Teachers and schools from 12 regions participated: 1, 4, 5, 6, 7, 9, 10, 11, 12, 16, 18, and 19. The major cities in these regions are Edinburg, Houston, Beaumont, Huntsville, Kilgore, Wichita Falls, Richardson (Dallas), Fort Worth, Waco, Amarillo, Midland, and El Paso. The only large urban district to participate was El Paso. This distribution is heavier in the east, which contains nearly 70% of the state population, than in the west. However, Regions 16, 18, and 19 (Amarillo, Midland, and El Paso) are clearly western. The distribution is also weighted more heavily to the north but still includes Regions 1 and 20 (Edinburg in the Rio Grande Valley and San Antonio).

Applicants were first assigned to condition randomly by school. Because the sample was so small and this was a pilot study, however, we adjusted the assignments to ensure minority representation in the treatment condition. One minority teacher and one rural teacher were switched into the treatment group.

Seventh-Grade Experiment Recruitment

SRI International (the principal institution on the project) and the Dana Center asked the regional ESCs to participate in the seventh-grade experiment in three ways: recruitment, teacher professional development support, and research support. The initial approach to the ESCs leaders was during at meeting at the Dana Center. Interested ESC leaders then applied to participate. Eight ECSs (from Regions 1, 6, 9, 10, 11, 13, 17, and 18) were given contracts in the first year. They represented the areas surrounding Edinburg, Huntsville, Wichita Falls, Richardson (Dallas), Fort Worth, Austin, Lubbock, and Midland.

The ESC leaders were then trained in the recruitment process. They were asked to approach schools and districts in a particular order prerandomized by the researchers and were given guidance about how to describe the experiment. They were given common, careful language about the purpose of the experiment that attempted to equate the benefits of both the "delayed" and "immediate" treatment groups equally. (Because the control teachers were to receive the treatment in the second year, this was technically a delayed-treatment condition.) While mentioning that the experiment involved technology and that our goals were for students to learn significantly more than they currently do, we emphasized how the curricula and the experiment were consistent with the TEKS standards and the Texas Assessment of Knowledge and Skills (TAKS). Regardless of condition, the opportunity was presented as an intensive chance to work on teaching rate and proportionality better. Because the control was a tested and highly regarded teacher professional development workshop and because mathematics teachers are generally less positive about using computer technology than any other kind of teacher (Becker et al., 2000), this message was thought to balance the attractiveness of the control and experimental conditions.

ESC leaders were asked to recruit as many teachers within their regions as they could. They were told that the research team would select the applicants from this pool and that the regions with the most applications would be the sites for the four workshops. ESC leaders approached district and school personnel and recruited through their direct contacts with teachers. They were not required to report on the specific contacts they made or the content of particular conversations or e-mails. They did report (1) distributing letters and flyers to teachers and to administrators at the district and school level, (2) administration of consent forms signed by district representatives or school principals confirming that the teachers could participate and that the technological resources would be provided, and (3) the number of application forms distributed to teachers. The application forms were very simple, asking little more than contact information and whether the teacher planned to teach seventh-grade mathematics the next year, would agree to be in either the treatment or control group as assigned, and had access to required technology.

Selection and assignment occurred at the school level. All applicants who met minimal criteria (would be teaching seventh grade mathematics and would have access to appropriate technology) were kept in the recruitment pool, resulting in 218 applicants. All schools with one or more teacher applicants were assigned a random number and ordered accordingly. With school as the unit of assignment, the first 140 applicants were assigned to either the treatment or control group (every other school was assigned to the treatment group, the rest to the control). The remaining schools were on the waiting list. Then applicants were invited to participate in the workshop and were requested to confirm their attendance. Any slots remaining before the workshop date were then allocated according to applicants' place on the waiting list.

In some cases, applicants who had scheduling conflicts were assigned to the workshop (treatment or control) that best fit their schedule. Teachers were not informed beforehand which condition they had been assigned to, so this reassignment did not compromise random assignment. Workshops were hosted at ESCs in Regions 1, 11, 13, and 18. Teachers from other regions were accommodated at the closest or neighboring ESC (i.e., ESC 11 hosted teachers from Region 10, ESC 13 hosted teachers from Region 6, and ESC 18 hosted teachers from Region 17). Although Region 18 is by itself larger than the state of Indiana, the travel was considerably less than in the pilot. The project reimbursed all eligible travel expenses.

Compared with the recruiting process used in the pilot study, the process for the full seventh-grade experiment resulted in more applications. It also meant that the research team did not have direct or personal contact with the teachers, nor did it have close control over who was approached and what precisely they were told.

The sample for the second year consisted of those teachers from the first year who remained in the experiment.

Eighth-Grade Experiment Recruitment

ESCs participating in the seventh-grade experiment were invited to assist with the eighth-grade experiment. Given the ongoing relationship, a conference call (not face-to-face meeting) was conducted to answer any questions or concerns. The ESC leaders were asked not to recruit from schools with teachers participating in the seventh-grade experiment to avoid cross-influence between the samples. The ESC leaders felt that recruitment numbers would be lower given this constraint because the pool of potentially eligible and interested middle school campuses had been significantly diminished by the seventh-grade experiment.

The ESCs that participated were 9, 10, 13, 17, and 18. ESCs 1, 6, and 11 opted out. The specifications to the recruiters were similar to those in the seventh-grade experiment but with a few important differences. In the eight-grade experiment, the ESC personnel were not given a particular order in which to approach the schools or teachers, and interested teachers were asked to recruit friends. Furthermore, rather than specifying a particular cutoff for a district, ESC leaders were told that everyone who applied could attend a workshop, although only some would be selected to participate in the experiment.

The goal was to invite 80 teachers to the workshops, but not enough applications had been received by the cutoff date. Therefore, all eligible applicants were invited to a workshop. The process of assignment (treatment or control) was the same as in the seventh-grade experiment. Scheduling conflicts were also handled in the same manner as in the seventh-grade experiment, with teachers who had a conflict attending the workshop that best fit their schedule. In this experiment, the treatment workshop was focused on using SimCalc to teach linear function, and the workshop for the control was the Dana Center-designed TMT3 (Teaching Mathematics Through Technology), which focuses on another technology to teach statistics. Another difference from the seventh-grade experiment was that in the eighth-grade experiment, the ESC leaders themselves delivered both the control and the treatment workshops for all teachers in their region. In the seventh-grade experiment, the originator of the seventh-grade SimCalc curriculum had given the treatment workshop, and one of the pioneers of the control workshop from the Dana Center had delivered it. Eighth-grade experiment teachers attended workshops at their local ESC. The project reimbursed all eligible travel expenses.

Properties and Characteristics of Our Samples

Tables A-1 through A-9 in the appendix show the properties and characteristics of the samples we obtained through these recruitment practices.

The first three tables present basic descriptive statistics for participants across the three studies. Because the seventh-grade experiment was conducted across 2 years and some attrition occurred between years, we present the first and second year in separate columns. Table A-1 presents the number of participants who completed the pilot, seventh-grade Year 1 and Year 2, and eighth-grade experiments; the number in each condition; and the average number of students who participated. Table A-2 shows the characteristics of the teachers in the pilot, seventh-grade Year 1, seventh-grade Year 2, and eighth-grade experiments. Table A-3 presents the campus characteristics for each of the studies. An overall observation is that we obtained a diverse sample in all studies.

Tables A-4 and A-5 further describe the teachers in the seventh-grade experiment, this time in comparison to the full population of teachers in the state and in the regions in which our study was active. One can see that the sample is reasonable representative of larger populations. Table A-4 focuses on teacher characteristics, whereas Table A-5 presents campus characteristics.

The next two tables present information about attrition across four different points in time in the seventh-grade experiment: applying, completing a workshop, completing the first year of the experiment, and completing the second year. Table A-6 compares the number and characteristics of the teacher applicants across these time points. Table A-7 shows the campus characteristics of participating teachers at each of the time points. An overall observation is that the characteristics of the sample at each time point do not change markedly.

The next two tables present data on attrition in the eighth-grade experiment. Table A-8 presents statistics for teachers who applied for and who completed the eighth-grade experiment, and Table A-9 shows the statistics at the campus level.

Overall, these tables are characterized by remarkable similarity across groups. Only in the small pilot sample were there any statistically significant differences between the control and treatment groups. Because these differences have been treated extensively in other reports (Tatar et al., 2008; Tatar, Ravitz, Stroter, & Zin, 2008), they are not discussed here.

Similarities Between the Samples: A Wide Variety of Teachers

Although no claim can be made that the samples are systematically representative, one property that carries across all three is that they do not represent a narrow sample either with respect to teacher or campus characteristics. All three experiments involved a variety of teachers in terms of age, experience level, and teaching philosophy and a variety of campus locations, school sizes, and ethnicities. Furthermore, apart from the qualities that we can and have measured, the separation between the research team and the recruitment personnel and processes in the seventh- and eighth-grade experiments argues a priori that we accessed a different kind of teacher and setting than typical design research projects, which only recruit teachers nearby to a major university.

Table A-10 shows the means for reported attitudes of teachers in the seventh- and eighth-grade experiments. In all samples, teachers ran almost the full gamut of orientation toward teaching, as measured by a subscale of the TLC (Becker & Anderson, 1998) measure of traditional versus constructivist teaching styles (Table A-10). In the pilot study, we were able to gather much additional contextual and attitudinal data about the teachers. On the basis of those data, Tatar, Ravitz, Stroter, and Zin (in press) were able to show that if the teachers strayed from the representative in ways that we measured, it was not because of a particular or extreme approach to teaching or to mathematics but because they were seekers, drawn to trying new things.

Differences in the Populations

Several differences are evident in the populations across the studies. One prima facie difference is that in the pilot we had participation from the El Paso school district, one of the 11 large urban districts in Texas, but no large urban district participated in either the seventh- or eighth-grade experiments. An additional large difference is in the percentages of teachers who had master's degrees: 38% in the pilot and 18% and 14% in the seventh- and eighth-grade experiments, respectively, compared with the Texas state average of 20% at these levels of instruction. Other differences were apparent in the Hispanic and African-American populations and in poverty levels.

Hispanic Population

The Hispanic representation differed considerably in the three experiments. The pilot drew teachers from El Paso, where 84% of households in the 2000 census self-identified as Hispanic, 75% reported speaking a language other than English at home, and 24% were below the poverty line (http://quickfacts.census.gov/qfd/states/48/48141.html).

El Paso did not participate in the full seventh-grade or the eighth-grade experiments. However, we had considerable participation from Region 1 in the first year of the seventh-grade experiment. Region 1 is in the Rio Grande Valley, next to the Mexican border. Census figures show that, similarly to El Paso, most of the counties in the Rio Grande Valley are 86–98% Hispanic, with upwards of 81% of households speaking a language other than English. It is also poor, with 22–36% of the households reporting incomes below the poverty line.

Despite these similarities, Dana Center personnel who have worked in the region and other people familiar with Texas told us that these regions represent quite different cultural groups. One indicator of this is that although poverty levels appear similar at the county level, 66% of adults over age 25 in the El Paso region report having high school degrees, whereas only 35–58% of adults in the Rio Grande counties report similar attainment. Additionally, although the county poverty levels appear roughly similar, the Rio Grande region has many schools in which 100% of the children are eligible for free or reduced-price lunch.

Nonetheless, participation from Region 1 ensured a large Hispanic presence in our seventh-grade sample at both the student and the teacher levels. However, just before the second year of the seventh-grade experiment, the region received a very large block grant (tens of millions of dollars) to improve mathematics instruction, and almost all the ESC leaders, administrators, and teachers felt unable to continue with our experiment. Eight out of 21 teachers continued, 2 in the immediate-treatment group (which repeated the intervention for a second year) and 6 in the delayed-treatment group (which had not previously received the target intervention). The ESC also declined to participate in the eighth-grade experiment.

Thus, we had only 10 Hispanic teachers in the second year of the seventh-grade experiment compared with 22 in the first. Furthermore, the percentage of Hispanic students in campuses in the sample declined from 47% to 42%.

In the eighth-grade experiment, we had even fewer: 7 Hispanic teachers and an average campus Hispanic population of 32%. The difference between the seventh-grade Year 1 and eighth-grade Hispanic population was statistically significant ($t(148) = 2.95$; $p < .01$), with a concomitant gain in the White population.

Because the Rio Grande Valley is so poor, its withdrawal was in large measure responsible for a significant difference in the seventh-grade Year 1 and eighth-grade samples in school poverty rates. Whereas 53% of the students in campuses in the seventh-grade Year 1 experiment were eligible for free and reduced-price lunch, only 42% were similarly eligible in the eighth-grade sample (Table A-3) ($t(148) = 2.53$; $p < .05$).

Thus, the percentage of Hispanic enrollment was extraordinarily highly relative to the campus poverty levels in schools of teachers who participated only in Year 1 of the seventh-grade experiment, accounting for almost all the variance in these variables (Figure 1a; R2 = 0.91). Hispanic enrollment played an important but somewhat smaller role in explaining variation in poverty levels for those who continued in Year 2 (Figure 1b; R2 = 0.73) and a still important but significantly reduced role for those who participated in the eighth-grade experiment (Figure 1c; R 2= 0.57). The differences in levels of correlation were statistically significant ($F(2, 147) = 9.23$, $p < .000$)

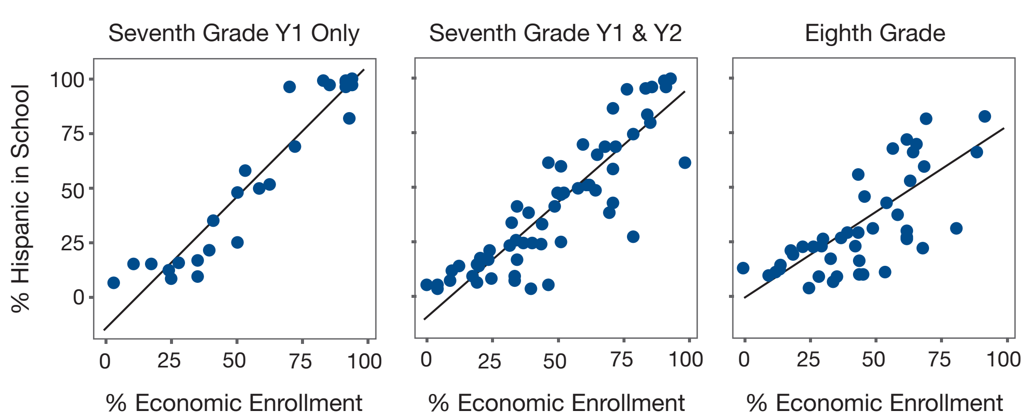

Figure 1: Relationship between Hispanic population and campus poverty level in classrooms that participated the seventh-grade experiment and in the eighth-grade experiment

There was also a decline in English as a Second Language (ESL) students, from 7.7% to 4.3% of the average campus population ($t(149) = 2.07$, $p < .01$). Because ESL students were not a specifically identified priority for the experiments, we do not see this as a critical flaw.

African-American Population

The African-American population was not well represented in any of our experiments, either at the teacher or the student level. Representation was a bit better in the pilot: With a sample of only 25 teachers applying, we had 2 African-American teacher participants, or 18% of the sample, which appears to be close to Texas average of 15% for seventh-grade mathematics teachers. Also in the sample were two campuses with 60–80% African-American students.

In the seventh- and eighth-grade experiments, the representation of African-American teachers was similar to that in the regions of our studies. Yet this was 2%, so that we had only one African-American teacher in the seventh-grade sample and three in the eighth grade. The mean campus ethnicity was also quite low, with no school in the seventh-grade experiment having more than 22% African-American participants and none more than 39% in the eighth grade. Schools thought to have an African-American culture by virtue of their high African-American enrollment were entirely unrepresented.

In no case were African-Americans underrepresented in a statistical sense, but a proportional representation did not allow adequate testing of the learning gains of this important subgroup.

High and Low Poverty

We already remarked on the relationship between the participation of Region 1 in our project and school poverty. Although all three samples contained a range of percentages of students eligible for free and reduced-price lunches, which may be used as an index of poverty and socioeconomic standing, high-poverty schools were better represented in the first year of the seventh-grade experiment. As shown in Figure 2, those teachers who participated only in the first year of the seventh-grade experiment came from schools with particularly high poverty, teachers who continued in the second year were more neutral, and those who participated in the eighth-grade experiment were from schools with less poverty. Taken as a whole, the seventh-grade sample differed significantly in campus poverty from the eighth-grade sample ($t(148) = 2.54$, $p < .05$). However, there was no difference between those who continued in the second year of the seventh-grade experiment and those who participated in the eighth-grade experiment ($t(120) = 1.48$; $p < .14$).

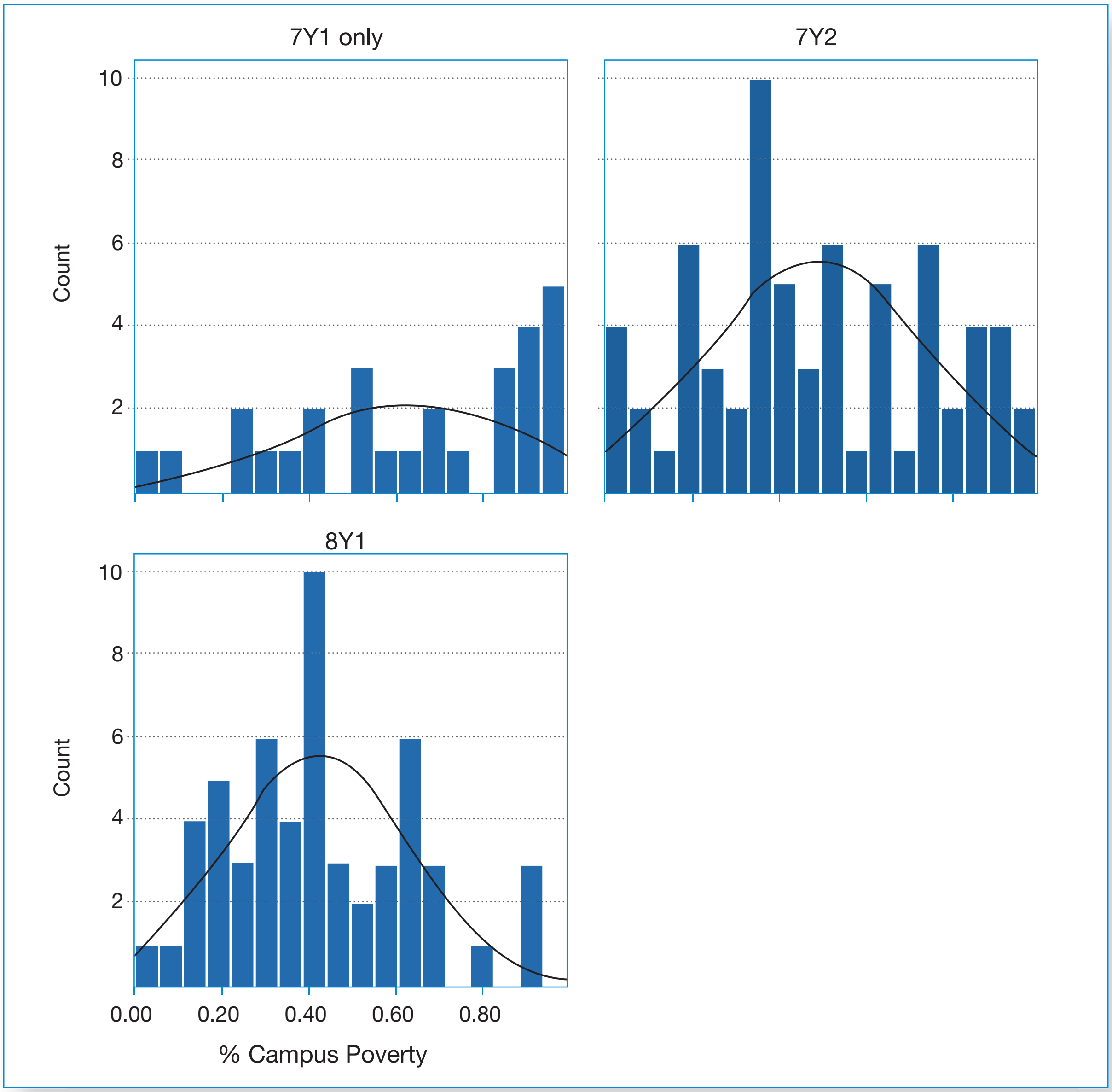

Figure 2: Distribution of campus poverty among teachers who participated in the seventh-grade experiment and in eighth-grade experiment

Attrition

Apart from the loss of Region 1, we did not see any evidence of differential attrition between conditions. (There were, as we stated, no significant differences between conditions in the seventh-grade Year 1, seventh-grade Year 2, or eighth-grade experiments.) Nor did there appear to be any important differences among applicants, those who completed the workshop (in some sense the real start of the project), those who participated in the seventh-grade Year 1 experiment, those in the seventh-grade Year 2 experiment, and those in the eighth-grade experiment, taken as a whole. The loss from the 140 teachers accepted into the seventh-grade experiment to the 117 who attended the workshop may be attributed to the long delay between application and the workshop. Of the 117 teachers, 95 completed Year 1, yielding only 19% loss in the course of a long and complex experiment; 67 of the 117 teachers, or 58%, who started Year 1 finished Year 2.

In addition to the reasons related to Region 1, most teachers who left the experiment claimed that they were reassigned, had lost access to the technology, or had family troubles.

Discussion

External Validity of the Findings

Variation in population provides important evidence in establishing a phenomenon. This project, taken as a whole, provides evidence that SimCalc can work at scale with a wide variety of teachers and in a wide variety of mixed campus settings. Internal analyses of subpopulations strengthened this evidence, as did the variations between seventh-grade and eighth-grade teachers and students and the differences in regions between the pilot and the full experiments.

However, extension to some populations may not be sufficiently established. Although we did show that SimCalc works in Region 1, that is arguably a very unusual place and high Hispanic populations are not otherwise well represented in our pool. From the viewpoint of recruiting and retention, the decline in the Hispanic population from the pilot to the eighth-grade experiment demonstrates how fragile the representation of certain groups in the sample can be. Even though the withdrawal of such a large percentage of the population appeared to be for a very good reason beyond the control of the experiment, it naturally raises questions about whether there are reasons beyond the stated ones.

An additional concern raised by this attrition is that it might be thought to cast doubt about the equivalency of the treatment and control groups in that more of the teachers in the delayed-treatment group (six) from Region 1 stayed in the experiment than teachers in the immediate-treatment group (two). This slight imbalance is not statistically significant and is probably unimportant.

Our samples also lacked high African-American populations and urban centers; further studies may be needed to generalize to those populations. We were initially alarmed about possible bias in recruiting when we saw the low percentages of African-American teachers and students in our seventh- and eighth-grade samples. However, when we realized that there was such a low incidence in the regions where we were recruiting, we were reassured about our within-region recruitment process.

Are there systematic reasons why we did not garner participation from regions and districts with larger African-American populations? This is quite possible. However, examining the distribution of African-Americans in Texas suggests that this population is primarily concentrated on the easternmost corridor of the state (near Louisiana) and that it is not evenly distributed, with many African-Americans in large urban areas. To ensure inclusion of that population, we could have targeted the regions including Houston, Beaumont, Tyler, or Texarkana. (We did have a teacher from the Tyler region in our pilot study.) We do not know what factors influenced some ESCs to participate and others not to. Additionally, we could have targeted large urban districts, which might have required bypassing the ESCs because they do not provide the services for those districts.

There could be other ways that our samples were special that went unmeasured. For example, districts, schools, and classrooms in which we conducted our project had to be functional and committed enough to allow participation, and the teachers had to perceive some benefit in volunteering. They had to see themselves as having the technological resources. Results may not generalize to less functional districts or teachers.

Last, of course, are the unsuspected differences that may exist in our samples from the representative because of either conditions in the world or some aspect of our recruitment processes that we do not suspect. Because we have three experiments conducted over several years in different schools with different teachers and students, the chances of conditions in the world leading to bias are reduced. However, it is possible that something about education in Texas in the early years of the 21st century does not generalize well. In fact, the stability in the school system that contributed to our choice of Texas increases the likelihood of this. Replication outside Texas is desirable.

The best argument against unsuspected bias in recruitment is replication with different recruitment methods. To a limited extent, we have this in the differences between the pilot study and the seventh- and eighth-grade experiments. These experiments certainly differ in the methods by which they obtained participation, with the personal contacts less a factor in the pilot. Approaching teachers directly through flyers or e-mail would take recruitment further in the direction of volunteering and give teachers who are isolated a greater chance to participate. An alternative approach would be to remove the volunteer element altogether at the teacher level by recruiting whole districts. This would ensure participation by reluctant teachers.

Lessons from Recruitment

By gathering and making public basic demographic information, Texas does a great deal to support inquiry in education. If Texas did not keep these data, we would have no mechanism for comparison.

Our studies were about the efficacy of SimCalc. They were not systematic explorations of recruitment practices. However, the differences between participation in the pilot and in the seventh- and eighth-grade experiments raise some interesting possibilities; it is possible that direct recruitment by researchers produces different samples than recruitment through trusted emissaries, such as the ESCs. Overall, however, we are encouraged by the relatively representative nature of teachers recruited regardless of the specific method.

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Appendix

Table 1. Teachers, Students and Class Sizes by Condition Across All Studies

	Pilot Sample			7th Grade Year 1		
Group	Teachers	Students	Class Size (mean)	Teachers	Students	Class Size (mean)
Control Treatment	10 11	176 181	20 16	47 48	825 896	21 19
Total	21	357	18	95	1,621	20
	7th Grade Year 2			**8th Grade**		
Group	Teachers	Students	Class Size (mean)	Teachers	Students	Class Size (mean)
Control Treatment	30 37	538 661	20 18	23 33	303 522	13* 16*
Total	67	1,199	19	56	825	15*

*Included here are only the students for whom we have complete data (both pretest and posttest)

Table 2. Teachers Characteristics by Condition Across All Studies

	Pilot Sample		7th Grade Year 1		7th Grade Year 2		8th Grade	
Teacher Experimental Condition	Control	Treatment	Delayed	Immediate	Delayed	Immediate	Control	Treatment
Total Teacher Count	10	11	47	48	30	37	23	33
% Female	90	67	81	77	81	78	82.6	84.8
Ethnicity								
%Caucasian	90	55	70.2	77.1	70.0	83.8	87.0	78.8
%Hispanic	.00	18	25.5	20.8	23.3	13.5	8.7	15.2
%Asian	.00	18	4.3	.00	6.7	.00	.00	.00
%African American	10	9.0	.00	2.1	.00	2.7	4.3	6.0
% Native American	.00	.00	.00	.00	.00	.00	.00	.00
Pk-12 Teaching experience (mean)	19 Range: 6- 44	11 Range: 2- 33	11 Range: 1-29	12 Range: 1- 40	10 Range: 1-27	13 Range: 1- 40	10 Range: 0-27	8 Range: 0-31
Pk-12 Math Teaching experience (mean)	14 Range: 4- 44	9 Range: 1- 33	10 Range: 1-29	11 Range: 1- 40	9 Range: 1-27	12 Range: 1- 40	10 Range: 0-27	8 Range: 1-32
Age (mean)	44 Range: 30-65	42 Range: 26-60	42 Range: 27-59	43 Range: 25- 58	42 Range: 27-59	43 Range: 25-68	42 Range: 25-62	41 Range: 27-64

Note: These statistics are from middle school mathematics teachers across 10 different regions in the state of Texas. Data source 2004-2005 Public Education Information Management System (PIEMS) and Teacher Background Questionnaire. There were no statistically significant differences found between any of our sample groups.

Table 3. Campus Characteristics by Condition Across All Studies

	Pilot Sample		7th Grade Year 1		7th Grade Year 2		8th Grade	
Teacher Experimental Condition	Control	Treatment	Delayed	Immediate	Delayed	Immediate	Control	Treatment
Total School Counts	NA	NA	37	36	25	31	19	24
% Eligible for Free lunch (mean)	46 Range: 20 - 75	62 Range: 25 - 89	53 Range: 3 - 99	54 Range: 2 - 94	56 Range: 11 - 99	49 Range: 2 – 94	43 Range: 0 - 89	42 Range: 0 - 92
School size (mean)	788 Range: 119 -1900	747 Range: 300 -1250	672 Range: 71 - 1490	619 Range: 102 - 2460	642 Range: 71 - 1490	541 Range: 102 – 1031	643 Range: 104 - 2245	634 Range: 121 - 1375
Campus ethnicity (mean)								
% Caucasian	38	27	44	47	40	57	61	55
% Hispanic	37	56	49	45	52	35	28	36
% Asian	2	1	2	2	2	3	2	2
% African American	22	16	5	5	6	5	9	7
% Native American	1	1	.00	.00	.00	.00	.00	.00

Note: Most statistics are from middle school mathematics teachers across 10 different regions in the state of Texas. Data source 2004-2005 Public Education Information Management System (PIEMS) and Teacher Background Questionnaire. Pilot sample statistics are from teacher provided information. There were no statistically significant differences found between any of our sample groups.

Table 4. 7th Grade Year 1 Teacher Characteristics by Attrition

	7th Grade Applicants	7th Grade Year 1 (completed workshop)	7th Grade Year 1 (completed year 1)	7th Grade Year 2 (completed year 2)
Total Teacher Count	218	117	95	67
% Female	78.9	81.2	78.9	79.1
ethnicity				
% Caucasian	65.6	69.0	73.7	79.1
% Hispanic	27.5	27.5	23.2	16.4
% Asian	2.3	2.6	2.0	3.0
% African American	1.8	.9	1.1	1.5
% Native American	.00	.00	.00	.00
% Missing	2.8	.00	.00	.00

Note: These statistics are from middle school mathematics teachers across 10 different regions in the state of Texas. Data source 2004-2005 Public Education Information Management System (PIEMS) and Teacher Background Questionnaire. There were no statistically significant differences found between any of our sample groups.

Table 5. 7th Grade Campus Characteristics by Sample by Attrition

	7th Grade Applicants	7th Grade Year 1 (completed workshop)	7th Grade Year 1 (completed year 1)	7th Grade Year 2 (completed year 2)
Total School Counts	151	90	73	43
% Eligible for Free lunch (mean)	57 Range: 1-100	55 Range: 1 – 100	54 Range: 2 – 94	56 Range: 11– 99
School size (mean)	690 Range: 71 - 2460	687 Range: 71 – 2460	645 Range: 71 – 2460	642 Range: 71 – 1490
Campus ethnicity (mean)				
% Caucasian	41	42	46	40
% Hispanic	51	51	47	52
% Asian	.02	.02	.02	.02
% African American	.06	.05	.05	.06
% Native American	.00	.00	.00	.00
% Bilingual Enrollment	.01	.01	.01	.01
% ESL Enrollment	.10	.11	.08	.06
% Gifted & Talented Enrollment	.10	.10	.10	.10
% Special Education Enrollment	.14	.13	.13	.14

Note: These statistics are from middle school mathematics teachers across 10 different regions in the state of Texas. Data source 2004-2005 Public Education Information Management System (PIEMS) and Teacher Background Questionnaire. There were no statistically significant differences found between any of our sample groups.

Table 6. Teachers Characteristics Compared to Regional Distribution

	7th Grade Year 1	7th Grade Year 2	7th Grade	7th Grade Year 2 (completed year 2)
Total Teacher Count	95	67	1,452	7,154
% Female	78.9	79.1	72.6	73.0
School size (mean)	690 Range: 71 - 2460	687 Range: 71 – 2460	645 Range: 71 – 2460	642 Range: 71 – 1490
Ethnicity				
% Caucasian	73.7	79.1	80.3	77.3
% Hispanic	23.2	16.4	6.8	13.6
% Asian	2.0	3.0	1.2	1.4
% African American	1.1	1.5	11.4	7.4
% Native American	.00	.00	.03	.03
% Missing	.00	.00	.00	.00
% With Master's	16.8	13.4	17.4	19.9
Pk-12 Teaching experience (mean)	10 Range: 1- 31	10 Range: 0 - 41	10 Range: 0 – 43	11 Range: 0 - 46
Pk-12 Math Teaching experience (mean)	10 Range: 1 - 40	10 Range: 1- 40	NA	NA
Age (mean)	43 Range: 25 - 68	43 Range: 25 - 68	42 Range: 23 – 71	41 Range: 21 - 75

Note: These statistics are from middle school mathematics teachers across 10 different regions in the state of Texas. Data source 2004-2005 Public Education Information Management System (PIEMS) and Teacher Background Questionnaire. There were no statistically significant differences found between any of our sample groups.

Table 7. Campus Characteristics Compared to Regional Distribution

	7th Grade Year 1	7th Grade Year 2	7th Grade Math Teachers in our Regions	7th Grade Math Teachers in Texas
Total School Counts	73	43	243	1,315
% Eligible for Free lunch (mean)	54 Range: 02 – 94	56 Range: 11– 99	47 Range: 00 – 100	51 Range: 00 - 100
School size (mean)	646 Range: 71- 2460	642 Range: 71 – 1490	737 Range: 27 – 1720	761 Range: 00 – 2528
Campus ethnicity (mean)				
% Caucasian	46	52	32	47
% Hispanic	47	41	47	36
% Asian	.02	.02	03	02
% African American	.05	.05	18	15
% Native American	.00	.00	.00	.00
% With Master's	16.8	13.4	17.4	19.9
% Bilingual Enrollment	.00	.00	.01	.01
% ESL Enrollment	.08	.06	.06	.07
% Gifted & Talented Enrollment	.10	.10	.12	.10
% Special Education Enrollment	.13	.14	.13	.14

Note: These statistics are from middle school mathematics teachers across 10 different regions in the state of Texas. Data source 2004-2005 Public Education Information Management System (PIEMS) and Teacher Background Questionnaire. There were no statistically significant differences found between any of our sample groups.

Table 8. 8th Grade Teacher Characteristics by Attrition

	8th Grade Applicants	8th Grade (completed workshop)	8th Grade (completed the year)	8th Grade Math Teachers in our Regions	8th Grade Math Teachers in Texas
Total Teacher Count	88	63	56	2,110	7,225
% Female	84.0	85.7	82.1	75.2	72.8
Ethnicity					
% Caucasian	56	82.5	82.1	81.6	77.3
% Hispanic	34	11.2	12.5	6.7	13.6
% Asian	.02	.00	.00	1.8	1.5
% African American	.08	6.3	5.4	9.5	7.4
% Native American	.00	.00	.04	.03	
% Missing	.00	.00	.00	.00	
% With Master's	13	15.9	12.5	19.9	19.9
Pk-12 Teaching experience (mean)	8 Range: 0 - 31	9 Range: 0 - 32	9 Range: 0- 31	10 Range: 0 – 44	11 Range: 0 - 46
Pk-12 Math Teaching experience (mean)	8 Range: 0 - 31	8 Range: 0 - 32	8 Range: 1- 32	NA	NA
Age (mean)	38 Range: 23 - 62	39 Range: 23 - 62	42 Range: 25- 64	41 Range: 22 – 76	42 Range: 22 - 76

Note: These statistics are from middle school mathematics teachers across 10 different regions in the state of Texas. Data source 2004-2005 Public Education Information Management System (PIEMS) and Teacher Background Questionnaire. There were no statistically significant differences found between any of our sample groups.

Table 9. 8th Grade Campus Characteristics by Attrition

	8th Grade Applicants	8th Grade (completed workshop)	8th Grade (completed the year)	8th Grade Math Teachers in our Regions	8th Grade Math Teachers in Texas
Total School Counts	70	51	43	332	1,330
% Eligible for Free lunch (mean)	44 Range: 0 - 92	43 Range: 0 - 92	42 Range: 0 – 92	45 Range: 0 – 99	51 Range: 0 - 100
School size (mean)	581 Range: 70 - 2175	598 Range: 70 - 2245	638 Range: 104-2245	780 Range: 24 – 1702	760 Range: 0 -2528
Campus ethnicity (mean)					
% Caucasian	55	57	57	47	46
% Hispanic	34	33	32	35	37
% Asian	.02	.02	.02	.04	.02
% African American	.08	.07	.08	15	15
% Native American	.01	.01	.01	.00	
% Bilingual Enrollment	.00	.00	.00	.00	.00
% ESL Enrollment	.05	.05	.04	.07	.07
% Gifted & Talented Enrollment	.10	.10	.10	.11	.10
% Special Education Enrollment	.14	.14	.14	.13	.14

Note: These statistics are from middle school mathematics teachers across 10 different regions in the state of Texas. Data source 2004-2005 Public Education Information Management System (PIEMS) and Teacher Background Questionnaire. There were no statistically significant differences found between any of our sample groups.

Table 10. Teachers Attitudinal Data by Sample Group Across All Studies

	7th Grade Year 1	7th Grade Year 2	8th Grade
Total Teacher Count	95	67	56
Teaching Orientation by TLC 1=Traditional to 5=Constructivist	2.55 Range: 1 – 4.5	2.61 Range: 1 – 4.3	2.88 Range: 1 – 5.0

*TLC refers to the Teaching, Learning, and Computing Survey. Note: These statistics are from middle school mathematics teachers across 10 different regions in the state of Texas. Data source 2004-2005 Public Education Information Management System (PIEMS) and Teacher Background Questionnaire. There were no statistically significant differences found between any of our sample groups.

Table 11. Teacher Material Distribution and Return

	7G			8G		
	TOTAL	iT	dT	TOTAL	SimCalc	TMT3
Total # in Regions						
Applied	218			88		
Invited to Workshops	140	70	70	0		
Completed Summer Workshops	117	58	59	0		
Received Stipend 1	117	58	59	0		
Travel Reimbursements	0			0		
Received Box	117	58	59			
Attended Planning Day	0			0		
Travel Reimbursements	0			0		
Returned Complete Box	95	48	47	0		
Received Stipend 2	96	48	48	0		
Completed Summer Workshops	62	29	33	63	37	26
Received Stipend 3	0			0		
Travel Reimbursements	0			0		
Received Box	65	34	31	63	37	26
Attended Planning Day	29	NA	29	17	NA	17
Travel Reimbursements	0			0		
Returned Box	0			56	33	23
Received Stipend 4	0			0		

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