UMass | Dartmouth

Kaput Center for
Research and Innovation in STEM Education

Scaling Up SimCalc Project

Diffusion of a Research-Based Innovation in Terms of Sustainability and Spread

Technical Report #2 | September 2009

Stephen Hegedus, Sara Dalton, Arden Brookstein, Derek Beaton, Rebecca Moniz
University of Massachusetts Dartmouth
Barry Fishman
The University of Michigan
Jeremy Roschelle, William Penuel
SRI International

RESEARCH CONTRIBUTORS:
SRI International; Virginia Polytechnic Institute and State University; The University of Texas at Austin; The University of Michigan; and the Charles A. Dana Center at the University of Texas at Austin

This is an official publication of the Kaput Center for Research and Innovation in STEM Education. The SimCalc Research team of the Kaput Center, University of Massachusetts Dartmouth is simultaneously preparing more detailed scholarly articles for researchers, teacher professional development, leaders, and policy makers. Contact shegedus@umassd.edu for more details.

University of Massachusetts Dartmouth
Kaput Center for Research and Innovation in STEM Education
200 Mill Road, Suite 150B
Fairhaven, MA 02719
774-929-3065

Diffusion of a Research-Based Innovation in Terms of Sustainability and Spread

Prepared by:

Stephen Hegedus, Kaput Center for Research and Innovation in STEM Education
Sara Dalton, Kaput Center for Research and Innovation in STEM Education
Arden Brookstein, Kaput Center for Research and Innovation in STEM Education
Derek Beaton, Kaput Center for Research and Innovation in STEM Education
Jeremy Roschelle, SRI International
Barry Fishman, The University of Michigan
William Penuel, SRI International
Rebecca Moniz, Kaput Center for Research and Innovation in STEM Education

Acknowledgments:
This material is based upon work supported by the National Science Foundation under Grant No. REC-0437861. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.

EXECUTIVE SUMMARY

Using survey methods, we investigate the potential sustainability and spread of the SimCalc approach as implemented in the Scaling Up SimCalc project. In the project, researchers recruited teachers to participate in experimental studies using SimCalc's integration of professional development, representational technology and paper curriculum. The experimental studies found that students learned more advanced mathematics when their teachers implemented the SimCalc approach. One year after the formal studies concluded, researchers gave teachers a survey to determine whether they were still using the materials ("stick") and/or sharing them with colleagues ("spread"). In addition, the survey asked teachers to report on factors that might explain stick and spread. Seventy-nine of 189 teachers responded to the survey, a response rate of 42%.

We found that 48% of respondents were still using SimCalc (stick) and 67% had shared information with a colleague about the materials (spread). Overall, given that no incentives were given to teachers for these behaviors and the materials were not formally adopted or required in their schools, we find this rate of continued use to be encouraging. An analysis of which aspects of materials teachers were using revealed that the teachers were using a coherent core sequence of lessons that were close to the designers' intent.

We took two different approaches to exploring factors that might explain why the SimCalc approach sticks or spreads among teachers. The first approach was based upon a general literature relating to diffusion of educational innovation; the second approach was based upon the SimCalc team's view of the appropriate attitudes and value-laden beliefs of a SimCalc teacher.

Building on the general literature, we found that "perceived coherence" of the SimCalc materials to teachers' instructional goals and accountability requirements was the major factor in stick and spread, with "help seeking" further contributing to spread. To our surprise, neither technology availability nor institutional barriers appeared to be correlated with stick or spread. This could be because the teachers in the study had sufficient technology and had already addressed institutional barriers through their prior participation.

Building on the SimCalc perspective, we created a value-index from 14 items of the survey which comprise two main components that were important: (1) teachers perceive the professional development they received as aligning with their value of the SimCalc materials in the classroom (2) teachers see the integration of software and curriculum as valuable and linked to their teaching. SimCalc materials were more likely to stick and spread with teachers who reported agreement with these components.

The main implication of these findings is to support the experimental research on scaling up, which found positive effects across a wide variety of classrooms, by showing that many teachers continue to use and spread the materials. Going beyond this implication, we see two approaches to advance sustainability: (1) increasing coherence with overall instructional goals and (2) increasing support for teachers' view of the value of these unique materials. Both the more general, "standards-based" and the more specific intrinsic value perspectives are likely to be important to the sustainability of materials, as teachers need to know that the materials "fit" requirements and that there is a unique reason to continue with these particular materials.

OBJECTIVES

We explore the potential sustainability and spread of SimCalc, a classroom-based mathematics intervention that uses technology-infused curriculum materials. The research reported in this report took place one year after the completion of a multi-year experimental study of the impacts on student learning of a replacement unit designed for middle-school mathematics. The goals of this report are to identify (1) teachers' enactment of the unit one year after the study was completed, (2) the extent of teachers' professional interactions with colleagues about the intervention, and (3) factors related to the intervention including teachers' beliefs about the quality of the intervention and the professional development (PD) they received.

We posit that these can predict diffusion of a particular form of an educational innovation in terms of the potential sustainability and spread of the resources used during the study.

THEORETICAL FRAMEWORK

Researchers have made steady progress in developing educational interventions that combine curriculum materials in mathematics and science with integrated technological tools to foster improved learning of standards-based content and to develop connections from grade level content to mathematics that will remain important throughout students' lives. These interventions have been called "coherent curricula" (Roseman, Linn, & Koppal, 2008), and they represent carefully designed products of collaboration such materials, in the form of replacement units, have been tested in rigorous experimental studies and shown to be effective in supporting student learning of complex mathematical concepts (Roschelle, Tatar, Shechtman, Hegedus et al., 2007).

An ongoing challenge to the success of such interventions, however, is to create changes in classroom practice that are both sustainable (the teacher continues to employ the intervention in the manner intended by its designers) and scalable (the use of the intervention spreads beyond its initial users in ways congruent with its designed intent) (Coburn, 2003; Fishman, 2005). Part of the challenge lies in the transition from "hothouse" research environments, where support and funding is plentiful, to everyday practice, where teachers and schools are subject to multiple competing demands (Fishman, Marx, Blumenfeld, Krajcik, & Soloway, 2004). A related problem is that as interventions move beyond the immediate involvement of their developers, shifts in practice or "lethal mutations" can occur such that the meaning of the original materials is lost (Brown & Campione, 1996). These implementation challenges are a critical hurdle in the progress of education reform (Penuel & Means, 2004; Rogan, 2007; Rowan & Miller, 2007).

One obstacle to successful implementation is the breadth of the state standards to which teachers must attend. There is evidence indicating that teachers are not well equipped to make decisions about materials selection with respect to standards (Schmidt & Prawat, 2006) and as a result many opt for coverage of topics that are superficially aligned with standards but that are a "mile wide and an inch deep" (Schmidt, Wang, & McKnight, 2005). Even if developers assure teachers that interventions are aligned with standards, teachers may still make choices that lead to shallow implementation with respect to the designers' original intent (Lin & Fishman, 2006). In response, there has been widespread call for PD to increase teacher capabilities with complex interventions (Borko, Elliot, & Uchiyama, 2002; Cohen & Hill, 2001). We have found that approaches emphasizing alignment can be too top-down (Penuel, Fishman, Gallagher, Korbak, & Lopez-Prado, 2009), and have sought to understand how teacher perspectives on alignment may shape their enactment choices and responses to new interventions and associated PD. We do not question the importance of ensuring that interventions are aligned with standards, but we believe that the teachers' understanding(s) also provide a crucial lens for the interpretation of standards and response(s) to them (Penuel, Fishman, Yamaguchi, & Gallagher, 2007; Spillane, 2000; Spillane, Reiser, & Reimer, 2002).

In this report, we explore how teacher perceptions of barriers to and supports for implementation are related to choices with respect to sustainability and spread *after* active involvement in the research project has ended. We operationalize *sustainability* as the continued use of the intervention in a manner consistent with their designed intent. We operationalize *spread* as teacher information exchange with colleagues about the intervention, which social networking researchers have shown to be a key activity in shaping norms in favor of adoption of innovations among a network of teachers (Frank, Zhao, & Borman, 2004; Sarama, Clements, & Jacobs Henry, 1998).

Our construct *spread* was originally referred to as "scalability". But since we talk more about post-experimental change, we believe our results illustrate dynamics linked to spread vs. more broad forms of scale and wide-scale implementation. This is especially important to

note as our study does not address fidelity of implementation in an empirical way. Our results focus on teachers' beliefs and values that could potentially predict stick and spread of the innovation post-intervention. For example, we investigate what teachers think SimCalc is useful and how can their perception of curriculum, and necessary support, impede or support sustainability and sharability or spreadability of the resource.

METHODS

Context

This research was conducted with 7th and 8th grade mathematics teachers who participated in the Scaling-Up SimCalc experimental studies (hereafter, "SimCalc") from 2004 to 2007. In the SimCalc project, teachers were recruited by local education agents, were provided all necessary materials including computer software, and were paid a stipend for their participation. Results from the SimCalc studies indicated that students of teachers who implemented the 2-to-3-week replacement unit on rate and proportionality performed as well on basic-level test items as students in control classrooms, and much better on challenge items, indicating a deeper understanding of the math concepts (Roschelle et al., 2007). The full intervention consisted of a 2-day professional development workshop, a follow-on planning meeting, printed curriculum guides with student and teacher materials, and software to help students visualize concepts on rate and proportionality.

Preliminary Design of the Survey

The project leadership and an external advisory board developed an initial set of seven questions based on data retrieved from the Kaput Center's diffusion database (a simple on-line tracking system of users who download SimCalc materials), and examples from the workshops conducted during the main study. We also reviewed transcripts of in-depth teacher phone interviews conducted at completion of the 7th grade SimCalc study described above from 2005

Table 1
Semi-structured interview agenda

Q1. Where have you seen or heard about SimCalc MathWorlds?

"**How did you first come across SimCalc?**"
"Did you learn about SimCalc at a workshop?"
"Did you read about SimCalc in a magazine or news report?"
"Did you hear about SimCalc from a colleague?"
"Did you learn about SimCalc from a web site or Internet search?"
Q2: When did you last use SimCalc and how would you describe your experience? If you used it in a class can you describe your students' experience as well?
"How did you use SimCalc?"
"Was your use of SimCalc part of some larger activity or curriculum? Can you tell me more about that?"
Q3. If you had to explain SimCalc to a teacher who had not used it before how would you describe it?
What is the "it"? A stand-alone software package? Or curriculum and software combined?
Q4. What are the reasons for using SimCalc in your classroom?
Q5. What are the problems or barriers for its effective integration?
Prompt teachers to think about barriers related to:
Technology, Administrator support, Integration with existing curricula, Time, Complexity or difficulty of use
Q6. In what ways have you discussed SimCalc with other colleagues (including teachers, administrators, curriculum directors)?
Depending on their response (negative or positive) make sure they give enough detail as to how and why they have discussed it in the way they describe
Q7. Is there anything you would like to mention regarding your experience of using SimCalc that you have not yet said?

thru 2007 focusing on:

- Teachers' familiarity with SimCalc,
- Previous use of SimCalc in the classroom, experiences and reasons for using SimCalc in the classroom,
- Important components of SimCalc that a teacher would share with a colleague,
- What teachers would tell their colleagues or administrators about SimCalc, and
- Any problems or barriers to implementing SimCalc in the classroom.

We asked 5 teachers (2 from New York, 2 from Massachusetts, and 1 from New Jersey) to answer these questions and help us refine them to meet our intended responses. Each had used some form of SimCalc in the past but were not a part of the SimCalc study.

The question set was refined (see Table 1) with follow-up prompts (as italics under each main question) and used as a semi-structured interview agenda for phone interviews with Texas teachers from the SimCalc study.

The question set became the basis for phone interviews conducted by research associates at the Kaput Center to various Texas teachers involved in the SimCalc Study. A total of 17 teachers from both 7th and 8th grade in varying regions of Texas were interviewed over the phone. These teachers varied according to their region, and we interviewed teachers who had not completed the intervention as well.

Design and Implementation of the Survey

Their responses were used to assess the feasibility of an on-line survey and to inform the design of such a survey particularly focused on the types of language necessary to maintain reliable feedback. From this work, we designed a 15-item survey focused on teacher perceptions of professional development, support for implementation, barriers to implementation, continuing use of the intervention materials, and communication with peers relating to the intervention materials, using items validated in prior studies of teacher PD (Garet, Porter, Desimone, Birman, & Yoon, 2001), implementation, and the scaling up of innovations (Fishman, Penuel, & Yamaguchi, 2006; Penuel et al., 2007). In addition, we used items from the TexTeams Survey (a PD initiative in Texas), and the "Post-Intervention" logs that we had asked teaching in the SimCalc study to complete. The full survey, its logic map, and complete source information for each item can be found in Appendix A.

New items created by the team pertained to social interactions, continued use of current SimCalc activities, reasons for no longer continuing to use SimCalc activities, components of SimCalc which are deemed valuable, and teachers' perceived importance of SimCalc. Using NVivo, we analyzed the phone interviews of our Texas Teachers and incorporated common phrases and answers into several of the response options for the new items.

The survey was administered using the on-line SurveyMonkey tool (see www.surveymonkey.com) with a front page outlining the purpose of the project. A small number of pre-service students at the Kaput Center took the survey to obtain a measure of approximately how long it would take and assess clarity.

Initially teachers were sent an email requesting their participation in the diffusion survey, how the data would be used and how long it would take. Incentives included a free SimCalc curriculum activity on completion of the survey and for participants who had dropped out of the SimCalc study we offered them a $25 gift voucher on completion of the survey.

Teachers had to enter their email address for identification. If teachers did not complete the survey after the initial email (04/18/08), a second email (05/08/08) was sent three weeks later to those who had not responded. Two weeks later a mailing (05/20/08) went out to the teachers who had still not responded to the survey. After two more weeks a phone call (06/04/08) was made to those who had not completed the survey and finally a week and a half after the phone call, a third email (06/13/08) was sent to teachers who had not completed the survey asking for their participation. Of the 189 teachers who were in the Scale-Up study, 79 participated in the diffusion survey. Following the third email, there was a negligible (2%) change in the numbers of

responders to total respondents and the survey was closed.

Participants

We contacted all 189 teachers who participated in the original SimCalc studies to request their participation in the survey. Seventy-nine teachers from the larger population responded and completed the online survey, for a response rate of 42%. Three responders had started the survey twice. Their responses were not consistent and so both responses for these 3 responders were removed leaving 73 survey responders, on whom we focus our analyses.

We conducted a non-response analysis in order to determine whether the teachers who responded to our survey differed in any meaningful way from teachers who did not respond. Using independent-samples *t*-tests, we compared initial student scores ($t(145.729)=-1.647$, $p>.05$), gain scores from pre-post testing ($t(146)=-.772$, $p>.05$), the geographic distribution of teachers (data from the original experiment) ($t(178)=1.516$, $p>.05$), and Campus level SES ($t(146)=-.371$, $p>.05$). None of these comparisons indicated a significant difference between response and non-response groups, giving us confidence that the results of this study are not biased as a result of response patterns.

RESULTS

From the overall population of respondents, 48% (which we refer to as "Stickers") reported on Item #11 that they are still using the SimCalc materials (indicating sustainability), and 67% (which we refer to as "Spreaders") had shared information with a colleague about the materials (indicating spread on Item #14). Items #11 and #14 are dichotomous response items and #11 involves logic that allows the responder to

Table 2
Summary of Predictor Variables

Predictor Variable	Summary of Question	Variable	Item	Scale
Help Seeking	ITEM #4 In the past year, how often have you asked colleagues in your school about each of the following:	COLHLP_1	For information about which SimCalc lessons worked well with their students.	1=Never 2=Once or twice 3=About once a month 4=A few times a month 5=At least weekly
		COLHLP_2	For help in setting up and using SimCalc software	
		COLHLP_3	For ideas about how to implement a particular SimCalc lesson	
		COLHLP_4	For ideas about how to keep students engaged while doing a SimCalc lesson	
		COLHLP_5	For ideas about how to embed SimCalc lessons within my curriculum	
Perceived Coherence	ITEM #6 Reflecting on your SimCalc PD, to what extent was the professional development characterized by the following?	PDS2_CG1	Consistent with your goals for your PD	1=Not at all 2=Not sufficiently 3=Sufficiently 4=Very much
		PDS2_CG2	Consistent with reform ideas within your school or department related to teaching practice	
		PDS2_CG3	Builds on what you learned in previous PD experiences	
		PDS2_CG4	Designed to support district standards/ curriculum frameworks	
		PDS2_CG5	Designed to support state standards/ curriculum frameworks	
		PDS2_CG6	Designed to support state assessments	
		PDS2_CG7	Designed to integrate technology into your teaching	
Technology Barrier	ITEM #10 In your implementation of SimCalc, to what extent has each of the following been a barrier to implementing SimCalc with your students?	IMP_BAR3	Difficulty running the software on my schools' computers	0=Not applicable 1=Not a barrier 2=Minor barrier 3=Major barrier
		IMP_BAR4	Lack of technology access (my school has computers, but I could not access them)	
		IMP_BAR5	Lack of technical support for using computers and software	
		IMP_BAR6	Lack of computer equipment (my school does not have sufficient computers)	
Institutional Pressures	ITEM #10 In your implementation of SimCalc, to what extent has each of the following been a barrier to implementing SimCalc with your students?	IMP_BAR1	Difficulty finding time to prepare for implementing SimCalc.	0=Not applicable 1=Not a barrier 2=Minor barrier 3=Major barrier
		IMP_BAR2	Difficulty completing activities within the suggested time period.	
		IMP_BAR12	Lack of alignment to content tested on the TAKS	
		IMP_BAR13	The material took too long to complete, it interfered with teaching content for the TAKS.	

highlight which parts of the SimCalc curriculum they are still using (i.e., are still sticking with). These are our two main dependent variables.

Initially, we developed four sub-scales from the survey data which could potentially be predictor variables in a regression model (see Table 2 as an extraction from the main survey to be found in Appendix A). We created a 5-item scale ($\alpha = 0.92$) related to *help-seeking*, i.e., teachers asking colleagues for help related to the intervention. We created a 7-item scale related to teacher *perceptions of coherence* ($\alpha = 0.94$), which is a sum of teacher ratings with respect to how coherent the program was with their goals for professional learning, and their school's and district's goals for mathematics. We created a 4-item scale related to *technology barriers* ($\alpha = 0.83$), indicating how well supported teachers felt in accessing needed computers and technical support. Finally, we created a scale related to *institutional pressures* ($\alpha = 0.72$), composed of items related to content coverage and competing time pressures. Descriptive statistics for the variables are shown in Table 3 and Table 4 represents the correlation matrix.

Table 3
Descriptive Statistics for Predictor Variables

Predictor Variable	Sample Size	Minimum	Maximum	Mean	SD
Help Seeking	68	5	20	7.0	3.4
Perceived Coherence	64	7	28	22.2	4.2
Technology Barriers	63	0	12	5.9	2.5
Institutional Pressures	63	4	12	7.6	1.8

Table 4
Correlation Matrix for Sub-Scales

	Coherence	Help Seeking	Technology	Institutional
Coherence		0.137	-0.144	-0.261*
Help Seeking			0.243	0.084
Technology				0.159

* Correlation is significant at the 0.05 level (2-tailed).

When we ran tests to compare stickers (Stk) vs. non-stickers (NonStk) and spreaders (Spr) vs. non-spreaders (NonSpr), we saw some significantly different results. There was a significant difference between stickers (Mdn=23) and non-stickers (Mdn=21) when comparing the construct *Perceived Coherence*, $U=344.5$, $p<.05$, and *Help Seeking*, $U=357.5$, $p<0.05$. Table 5 represents the descriptive statistics by group.

Table 5

Sub-scales	Sample Size		Minimum		Maximum		Mean		SD	
	Stk	NonSt	Stk	NonSt	Stk	NonSt	Stk	NonSt	Stk	NonSt
Help Seeking	35	28	5.0	5.0	20.0	20.0	7.63	6.50	3.69	3.13
Perceived Coherence	35	28	18.0	7.0	28.0	28.0	23.37	21.17	3.04	4.29
Technology Barriers	35	28	0	0	12.0	12.0	5.60	6.32	2.36	2.68
Institutional Pressures	35	28	4	4	12.0	11.0	7.31	8.04	1.97	1.57

Note. Stk=Stickers, NonStk=Non-Stickers

Conclusion 1: Teachers who continued to use the materials believed they cohered well with instructional goals and accountability requirements of their school and actively sought help from their colleagues regarding effective implementation.

Table 6 displays descriptive statistics by group, Spreaders vs. non-Spreaders. There are significant differences between groups for *Perceived Coherence* (U=227.0, p<0.05), and marginal differences for *Help Seeking* (U=251.5, p=0.06).

Table 6
Descriptive Statistics Between Spreaders and Non-Spreaders on the Predictor Variables

Sub-scales	Sample Size		Minimum		Maximum		Mean		SD	
	Spr	NonSp	Spr	NonSp	Spr	NonSp	Spr	NonSp	Spr	NonSp
Help Seeking	48	15	5.0	5.0	20.0	10.0	7.53	5.86	3.80	1.68
Perceived Coherence	48	15	13.0	7.0	28.0	28.0	23.00	20.46	3.41	4.37
Technology Barriers	48	15	0	0	12.0	12.0	5.90	6.00	2.29	3.23
Institutional Pressures	48	15	4	4	12.0	10.0	7.58	7.80	1.90	1.61

Note. Spr=Spreaders, NonSpr=Non-Spreaders

Conclusion 2: Teachers who shared the materials believed they cohered well with instructional goals and accountability requirements of their school and were positive in collaborating with other teachers and seeking help in implementing the resources.

The sub-scales *Institutional pressures* and *technology barriers* are not significantly different across our two groups. This was surprising so we examined the barrier Item #10 ("In your implementation of SimCalc, to what extent has each of the following been a barrier to implementing SimCalc with your students?") more closely with our dataset. A Principle Components Analysis (PCA) was conducted with a Varimax rotation to explore the latent variables in the data. We tentatively explored a 3-component structure which explained 62% of the total variance. We then created factor scores by summing the variables within each component and ran independent t-tests to measure differences in means between spreaders vs. non-spreaders, and stickers vs. non-stickers. *There were no significant differences between both groups for all three components.* In addition, the first component was almost identical to the existing *Institutional Pressures* sub-scale and so we concluded our analysis at that stage.

Conclusion 3: The constructs "Perceived Coherence" and "Help Seeking" can help build a model to predict stick and spread of an innovation but institutional pressures and technological barriers do not differentiate whether someone sticks or spreads.

CAN TEACHERS' VALUES AND BELIEFS OF AN INNOVATION DETERMINE STICK OR SPREAD?

We are attending to this question by establishing an *a priori* theoretical model of what we expect the beliefs and practices of a teacher with a "healthy" mindset are to be when aligned with the goals and intentions of the SimCalc resources. We have created a simple index of this model from our survey and tested it to see if it differentiates stick or spread. It should be noted here that the index is limited by the survey and is not a complete value-set.

From the 15 items of the survey and the 158 variables from all responses, we selected 17 variables to define a "model SimCalc teacher" that defines such expectations in response to our survey. These items were accumulated as a SimCalc Teacher Index variable (hereon called the "SCT Index"). The research team collectively analyzed answers to all questions in the Survey, as if they were teachers in the study. As a group, we eliminated questions that were deemed irrelevant to someone valuing SimCalc resources, or desirable/undesirable for any teacher, i.e., were not directly attributable to intentions to spread. Please refer to Appendix B

Table 7
Elements of the SimCalc Teacher Index (SCT Index)

Variable	Variable Scale	Description
PDS1_AL5	0, 1, 2, 3, 4, 5	Usefulness of SimCalc PD activities: Discussed instructional techniques
PDS1_AL1	0, 1, 2, 3, 4, 5	Usefulness of SimCalc PD activities: Participated in a whole-group discussion or session
STK_VAL3	0, 1, 2, 3, 4	How SimCalc was useful to teaching and learning: The curriculum materials
PDS1_AL2	0, 1, 2, 3, 4, 5	Usefulness of SimCalc PD activities: Participated in a small-group discussion or session
STK_VAL6	0, 1, 2, 3, 4	How SimCalc was useful to teaching and learning: Students working in pairs or as part of a group
PDS1_AL8	0, 1, 2, 3, 4, 5	Usefulness of SimCalc PD activities: Making connections between SimCalc materials and standards
STK_VAL1	0, 1, 2, 3, 4	How SimCalc was useful to teaching and learning: Use of simulation in software
STK_VAL2	0, 1, 2, 3, 4	How SimCalc was useful to teaching and learning: Use of interactive graphs in software
STK_VAL7	0, 1, 2, 3, 4	How SimCalc was useful to teaching and learning: Curriculum in conjunction with the software
PDS1_AL6	0, 1, 2, 3, 4, 5	Usefulness of SimCalc PD activities: Practiced using software
PDS2RAT7	1, 2, 3, 4	SimCalc PD prepares you to: Explain why a procedure students used worked to solve a problem
PDS2_CG1	1, 2, 3, 4	Characterize SimCalc PD: Consistent with your goals for your professional development
PDS2RAT4	1, 2, 3, 4	SimCalc PD prepares you to: Solve problems that have more than one correct answer
PDS2_CG7	1, 2, 3, 4	Characterize SimCalc PD: Designed to integrate technology into your teaching

0 represents "I cannot recall" or "Not applicable"

Those variables without a 0 did not have "I cannot recall" or "Not applicable" as an option

for a full description of the rationale for inclusion of each item. We offer here a brief summary.

Questions 13, 14 and 15 were eliminated after lengthy discussion. These questions have a number of desirable traits of sharing (spreading) SimCalc and rating the value and worth of certain aspects of software and curriculum, but these were determined to not necessarily be specific to a model SimCalc teacher, rather a model teacher-advocate and/or a model advocate. Question 13 was also eliminated because many of the teachers are the sole mathematics teacher in their school or district. These questions were also eliminated because the number of variables selected would increase from 17 to 31. The point of this exercise was to find a minimal core subset of attributes, based on this survey, to define the SCT Index.

Question 11 was eliminated as a whole because it is specific to (a) stickers using specific curriculum, and (b) non-stickers defining why they are not sticking. Neither of these are specifically applicable to a general model of a SimCalc teacher. Also, Questions 9 and 10 were eliminated for similar reasons—these are defining issues that are not relevant to the model of a SimCalc teacher. One of the 17 variables selected (IMP_COV1) was discarded because it is dichotomous and all other variables have a Likert scale. Two more variables selected (IMP_PRACTICEC & IMP_PRACTICEE) were discarded because they involved skip logic and would decrease our survey population by 12 responders. The reliability of the index using 14 variables (see Table 7) is high ($\alpha = 0.909$).

Finally, we created a new indexical variable, *SCT Index*, which is the sum of the z-scores of responses to the variables that were selected to define the SCT Index. The higher the score on this index, the more in line a responder's value-mindset is with the expected values of the designers of the SimCalc innovation and the project leaders.

Table 8
Descriptive Statistics of the SCT Index

	N	Range	Min	Max	Mean		Std. Dev	Variance	Skewness		Kurtosis	
	Stat	Stat	Stat	Stat	Stat	Std. Error	Stat	Stat	Stat	Std. Error	Stat	Std. Error
SCT_Index	62	42.71	-26.64	16.07	-0.01	1.13	8.86	78.48	-0.44	0.30	0.64	0.60

Using the SCT Index to Examine "Stick" and "Spread"

The index was used to compare those responders who are still using SimCalc curriculum with those who are not and those responders who are sharing SimCalc materials with those who are not.

The SCT Index of those teachers who continued to use the SimCalc curriculum (M=1.738, SE=1.287) is significantly different (t(60)=-1.740, p(one-tailed)=.044) from the SCT Index of those teachers who did not continue to use the SimCalc curriculum (M=-2.132, SE=1.889). There is a small sized effect, d=.4377, r=.214.

Table 9
Differences Between Stickers and Non-Stickers

	"Spreaders"			"Non-Spreaders"			t(df)
Variable	n	M	SD	n	M	SD	
SCT_Index	34	1.738	7.507	28	-2.132	9.996	-1.740* (60)

*p<.05

The SCT Index of those teachers who shared the SimCalc materials (M=1.769, SE=1.132) is significantly different (t(60)=-2.974, p(one-tailed)=.002) from the SCT Index of those teachers who did not share the SimCalc materials (M=-5.585, SE=2.581). There is a medium to large sized effect, d=.822, r=.380.

Table 10
Differences Between Spreaders and Non-Spreaders

	"Spreaders"			"Non-Spreaders"			t(df)
Variable	n	M	SD	n	M	SD	
SCT_Index	47	1.769	7.765	15	-5.585	9.995	-2.974** (60)

**p<.01

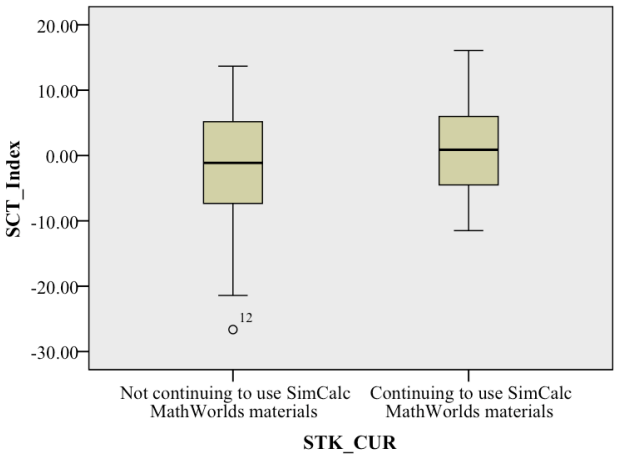

Figure 1: *Stickers and Non-Stickers*

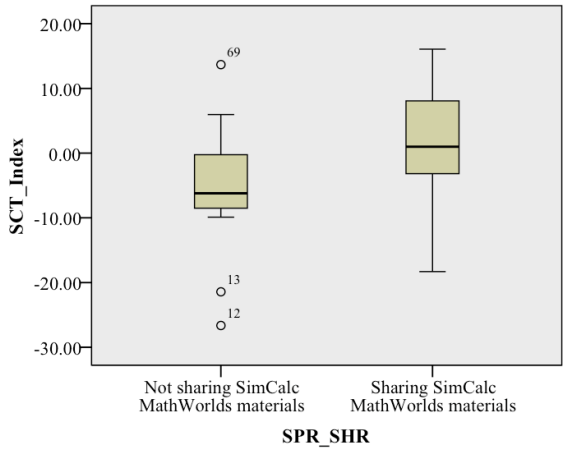

Figure 2: *Spreaders and Non-Spreaders*

Principle Component Analysis (PCA)

A Principle Components Analysis (PCA) was conducted on the 14 variables of the SCT Index to investigate whether there were more degrees of variance to the index that would be useful in our analyses as we differentiated between a "sticker" and a "non-sticker" or a "spreader" vs. a "non-spreader. To motivate the reader, this process was profitable as it produced two main components or sub-scales to measure differences within our sample.

The initial PCA yielded four components with both Varimax and Promax rotations. Component 4, however, consisted of only two variables (PDS2RAT7 and PDS2RAT4) contributing to the variance and so these two variables were removed from the analysis due to this weakness (Velicer & Fava, 1998). The scree plot (Catell & Vogelmann, 1977) and amount of variance explained in the first two components indicated that a two-component structure could be used with our data. The resulting PCA of the remaining 12 variables forcing 2 components accounted for 61.056% of the variance. Two more variables, PDS1_AL6 and STK_VAL3, loaded approximately equally on both components and were removed from the analysis.

Following this iterative procedure, we discovered that two components with the remaining 10 variables accounted for 63% of the variance and these were distributed across six of the original 14 variables for Component 1 and four of the original 14 variables for Component 2. Following the removal of these variables, we

ran tests to examine the suitability for running a final PCA on the remaining variables. The Kaiser-Meyer-Olkin measure of sampling adequacy for the sample (.784) is large (Kaiser, 1974). Bartlett's test of sphericity was significant (χ^2 (45) = 338.05, p < .0001). Diagonals for the anti-image correlation matrix were all above .5.

Following a Varimax rotation and forcing 2 components, all variables were significantly correlated (p<.01) with at least one other variable. These statistics indicate this structure represents our dataset well.

Table 11 illustrates the individual variables that comprise the components including their communalities. We define Component 1 as "Usefulness of SimCalc PD and consistency with personal aims" which accounts for 45.716% of the variance and Component 2 as "Value of SimCalc resources specifically to teaching and learning" which accounts for 17.617% of the variance.

Table 11
Rotated Component Matrix of Reduced SCT Index Variables

	Variables	Component 1	Component 2	Communality
Value PD and Coherence	PDS1_AL1	0.861		0.772
	PDS1_AL2	0.816		0.711
	PDS1_AL5	0.803		0.683
	PDS1_AL8	0.749		0.563
	PDS2_CG1	0.651		0.457
	PDS2_CG7	0.604		0.466
Value specific resources	STK_VAL1		0.925	0.861
	STK_VAL2		0.856	0.807
	STK_VAL7		0.848	0.275
	STK_VAL6		0.476	0.739

Extraction Method: Principal Component Analysis
Rotation Method: Varimax with Kaiser Normalization
Note. Factor loadings less than .4 are suppressed

The reliability for the two components is high indicating a sound set of scales to measure teacher's value and perception of the SimCalc program (see Table 12).

Table 12
Reliability of Components of SCT Index

Component	Description	α
1	Value PD and Coherence	0.86
2	Value specific resources	0.82

Each component describes value of the innovation in different aspects as would be expected since the index was developed with assumptions about value and a positive perception of the SimCalc program. The first component describes how teachers perceived the usefulness of the professional development piece of the SimCalc program, with specific active ingredients that cohere with their expectations for integrating technology into classrooms. The second component is focused on how teachers value and perceive the usefulness of the SimCalc software and supporting curriculum as a coherent whole. These two components account for over 63% of the variance.

These components describe important characteristics in understanding the importance of the SimCalc program, valuing critical components of the program including the software, curriculum, and professional development, and how it relates to classroom practice. These characteristics of innovation can be used to help explain spread (Rogers, 1995). The PCA has illustrated a reliable and theoretically sound set of sub-scales to measure teacher's value of the effectiveness of the innovation. We now use these sub-scales of the SCT Index to determine whether these factors are important in the scalability and sustainability of the SimCalc innovation.

Conclusion 4: We can create a reliable and rigorous measure of a teacher's perception of how valuable the SimCalc program is from a sub-set of items from the survey.

Table 13
Comparing Stickers and Non-Stickers with the SCT Index Components

	"Stickers"			"Non-Stickers"			t(df)
SCT_Index	n	M	SD	n	M	SD	
Component 1	34	0.198	0.778	28	-0.240	1.187	t=-1.742* (60)
Component 2	34	0.099	0.697	28	-0.120	1.280	t=-.858 (60)

Table 14
Comparing Spreaders and Non-Spreaders with the SCT Index Components

	"Spreaders"			"Non-Spreaders"			t(df)
SCT_Index	n	M	SD	n	M	SD	
Component 1	47	0.152	0.800	15	-0.477	1.389	t=-2.186* (60)
Component 2	47	0.141	0.768	15	-0.443	1.462	t=-2.021* (60)

Discussion

Our indexical variable which models a set of positive values towards the effectiveness and use of the SimCalc program is a good measure of stick and spread. Tables 13 and 14 both illustrate that the sub-scales of the SCT Index differentiate those who stick with the SimCalc program or not, and those who choose to spread it or not. Only the Component 2 sub-scale does not significantly differentiate the stickers from the non-stickers but since the stickers and spreaders are almost identical in this sample we will not focus on this result.

It should be no surprise that an index which measures positive values towards an innovation predicts whether someone wants to keep using such a program and/or share with others. We therefore summarize what particular key ingredients are necessary in the mindset of a teacher that might ensure, with some degree of reliability, the continued use of the SimCalc resources.

The SCT Index does factor reliably into two components. Each of these components is a significant factor in defining whether someone will continue to use the SimCalc resources and/or share it.

It is important to reflect on what this actually means in practice. If the sub-population of SimCalc users (within an experimental program) who wish to continue to use a resource after the program is finished can be defined by how they value a program, then this is critical for schools to acknowledge and for the SimCalc research team to acknowledge in their ongoing development and diffusion. Such critical, or key ingredients, need to be realized as more than just perceptions or values but needs for sustained use. For example, valuing the professional development implies that such a service is critical to be replicated outside of the experiment if future adopters or present users are to sustain its use.

We conclude this section with some recommendations for sustained use and which might well be germane to a wider variety of researchers and developers who are implementing educational technology innovations at scale. We abstract these recommendations from the structure of our SCT Index and expectations for sustained use based upon such modes of use and teachers' beliefs.

Recommendation 1. Clearly describe what types of classroom practice are expected in implementing the resource. For teachers who give attention to small-group learning (using software and curriculum) and whole-class discussion focused on reasoning and assimilation of ideas it is expected that uptake and sustained use of the resources would occur.

Recommendation 2. The software and associated curriculum are closely aligned and synergistically connected. Teachers need to value and understand the functional needs of the resources for successful use.

Recommendation 3. Ensure that teachers understand the innovative features of the SimCalc resources and how they add value to existing curriculum and offer opportunity for enhancing modes of practice.

Conclusion 5: Teachers who value the SimCalc program in terms of its alignment to existing classroom practice, synergistic linking of software and curriculum, and coherent professional development will continue to use and share the resources.

WHAT DO TEACHERS CHOOSE TO STICK WITH?

An important question surrounding the continued use, and the creation of advocates of SimCalc materials (software and curriculum) is "What curriculum is most valued by SimCalc MathWorlds® users?" Considering that the majority of users who continued to use the materials would also spread the materials (31 spreaders of the 35 stickers), we are interested in answering what curriculum is valued highly and used after the experimental study has completed.

In this section, we will only be looking at the seventh grade materials, as opposed to the eighth grade materials. Survey responses for those who used eighth grade curriculum were quite low.

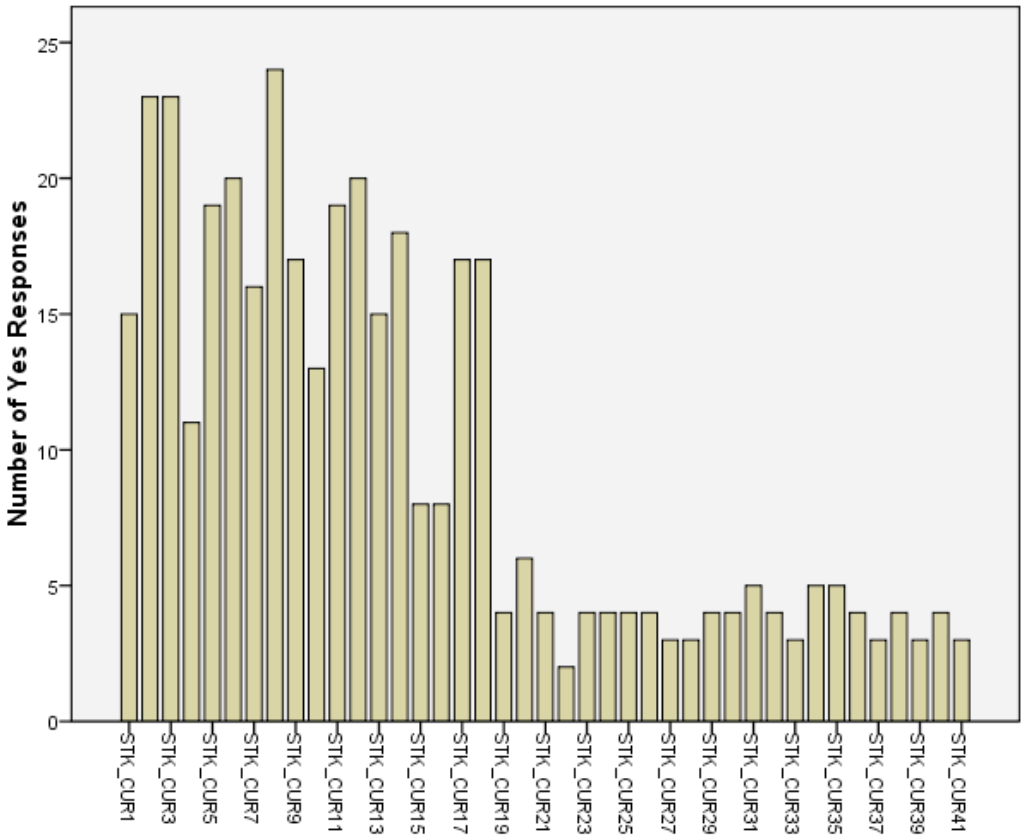

Figure 3: *A histogram displaying the number of positive responses (curriculum still in use). Seventh grade is STK_CUR1 through STK_CUR21; Eighth grade is STK_CURR22 through STK_CUR41 (noted in red).*

The frequency of responses illustrate that there are some activities that are continually used far more than others. These are:

- Activity 8. Run, Jace, Run (runjace1.smw) – 69% of responders still using
- Activity 2. A Race Day (araceday1.smw) – 66% of responders still using
- Activity 3. Another Race Day (another1.smw) – 66% of responders still using

Not only did these activities have high positive response rates, but also correlated with one another in the responses—indicating that these activities are being used together—as the curriculum was originally designed. A measure of similarity also displays that the response and usage of Activities 2, 3 and 8 are very similar. These activities focus on fundamental mathematical concepts that software was designed to address including interpreting multiple representations.

Analyzing Curriculum: By Grouping Activities

For those teachers responding positively to continued use of the curriculum, we asked which activities they were actually using. The following section describes various curriculum groupings, based on attributes of activities within the curriculum, the indices to measure them, and their relationship to the behavior of sharing the curriculum with others.

Indices are created based on the grouping of the questions, and defined by the responses. Each index (per group) is composed of a value between 0 and *n*, where *n* is the number of activities in the group.

Initially, the first groups of curriculum activities that were created were software document-based and non-software workbook-based. Software document-based activities account for 12 out of 21 activities, and non-software workbook-based account for 9 out of 21 activities, giving each a score range from 0-12 and 0-9, respectively. Table 15 illustrates statistically significant differences between spreaders and non-spreaders for software-based activities and non-software-based activities but we note the extremely small number of non-spreaders to make any serious conclusions:

Table 15
Difference Between Spreaders and Non-Spreaders for Software-Based Activities and Non-Software-Based

	"Spreaders"			"Non-Spreaders"			t(df)
Variable	n	M	SD	n	M	SD	
Software	31	6.4194	3.3938	4	1.25	2.5	-2.928(33)**
Non-Software	31	3.5484	2.6437	4	0.75	1.5	-2.057(33)*

*p<.05, **p<.01

Furthermore, groupings of the curriculum based on activity similarity were created. Each group below consists of similar activity criteria, or a relationship that is on-going from one activity to another. There are 5 groups of activities each with an index range that is a sum of the number of activities used within that group.

- Soccer Motion: Ten activities within the "Soccer Team" storyline that address motion, and position over time. Index range: 0-10 (Act# 1-9 & 14)
- Money: Four activities that address accumulation of money, or the cost of product(s). Index range: 0-4 (Act# 10, 15, 16, 19)
- Slope & Rate: Two activities that address slope & rate. Index range 0-2 (Act# 11, 21)
- Driving: Two activities that address motion with vehicular actors. Index range 0-2 (Act# 12, 13)
- MPG: Two activities that address the relationship between miles traveled and gallons of gas consumed. Index range 0-2. (Act# 17, 18)

Table 16 illustrates each group of activities, and their relationship to spreading vs. non-spreading, computed via independent samples t-tests.

Table 16
Groups of Activities and Their Relationship to Spreading vs. Non-Spreading

	"Spreaders"			"Non-Spreaders"			t(df)
Variable	n	M	SD	n	M	SD	
Soccer Motion	31	5.8387	3.4360	4	1.25	2.5	-2.569(33)*
Money	31	1.0645	1.26	4	0	0	-1.664(33)
Slope-Rate	31	0.7097	0.64258	4	0.25	0.5	-1.371(33)
Driving	31	1.1290	0.8462	4	0	0	-2.634(33)*
MPG	31	1.0323	0.98265	4	0.5	1	-1.018(33)

*p<.05

Whilst there are some significant differences, the numbers are too small to make any serious claims about which activities teachers who are sharing the resources prefer to share.

Table 17
Correlations Between Groups of Curriculum Activities and SCT Index Components

	SCT Index	Value PD and Coherence	Value specific resources
Soccer	0.267	0.195	0.239
Software	0.295	0.200	0.270
Non-Software	0.487**	0.484**	0.156
Money	0.438**	0.532**	0.014
Slope-Rate	0.502**	0.407*	0.270
Driving	0.220	0.035	0.321
MPG	0.267	0.234	0.106

* Correlation is significant at the 0.05 level (2-tailed).

** Correlation is significant at the 0.01 level (2-tailed).

Conclusion 6: Curriculum and teachers' perception of coherent conceptual strands within a curricula sequence are important factors in determining whether certain activities are shared with other teachers or continued to be used.

There are some strong correlations between teachers' SCT Index and the activities they are sharing. Table 17 highlights some significant correlations between teachers' values (as measured by the SCT Index) and certain groups of activities. Most notably, half of the groups of activities are significantly correlated with the first component of the SCT Index, teachers valuing the PD and seeing consistency with personal aims. This is an important factor in successful diffusion of innovations. It is important not only to believe in the form of the innovation but also its function and coherence within professional development.

CONCLUSION: EDUCATIONAL AND SCIENTIFIC IMPORTANCE

As researchers and educators struggle to implement interventions to improve student performance in accord with state and national standards, there is a tug-of-war between interventions that are designed according to our best understanding of "how people learn" (Bransford, Brown, & Cocking, 2000), such as the "coherent curriculum" work in science education, and less ambitious materials (Cohen & Ball, 1999). One could conclude that the logical response to some of our findings is to further reduce the complexity of the materials, essentially devolving them into discrete activities that can be done with or without the software (since access to and support for teaching with technology is another barrier). But this would represent a fundamental alteration of the original intent of the materials, which aim to help students reason about complex mathematics content by connecting it to their real-world experiences through hands-on explorations with data and visualization. Such understandings are not reached through either lecture or brief encounters with mathematical phenomena. We are both surprised and pleased that *so many* of the teachers continued to use and talk about the SimCalc materials with their colleagues after the conclusion of the research study.

The conclusions from this study, together with emerging evidence from related work (e.g., Penuel et al., 2007), point to factors that should be attended to in further research on how best to support implementation of rich technology-supported interventions in mathematics and science. The goal is both to develop frameworks for research that will allow us to better understand implementation success or failure, and also to inform the design of educational interventions that can be widely used to ensure that children have meaningful and deep interactions with core content.

REFERENCES

Borko, H., Elliot, R., & Uchiyama, K. (2002). Professional development: A key to Kentucky's educational reform effort. *Teaching and Teacher Education, 18*(8), 969-987.

Bransford, J. D., Brown, A. L., & Cocking, R. R. (Eds.). (2000). *How people learn: Brain, mind, experience, and school* (Expanded ed.). Washington, D.C.: National Academy Press.

Brown, A. L., & Campione, J. C. (1996). Psychological theory and the design of innovative learning environments: On procedures, principles and systems. In L. Schauble & R. Glaser (Eds.), *Innovations in learning: New environments for education* (pp. 289-325). Hillsdale, NJ: Erlbaum.

Catell, R. B., & Vogelmann, S. (1977). A Comprehensive trial of the Scree and KG criteria for determining the number of factors. *Multivariate Behavioral Research*, *12*(3), 289-325.

Coburn, C. E. (2003). Rethinking scale: Moving beyond numbers to deep and lasting change. *Educational Researcher, 32*(6), 3-12.

Cohen, D. K., & Ball, D. L. (1999). *Instruction, capacity, and improvement* (CPRE Research Report Series No. RR-043). Philadelphia, PA: University of Pennsylvania Consortium for Policy Research in Education.

Cohen, D. K., & Hill, H. C. (2001). *Learning policy: When state education reform works*. New Haven, CT: Yale University Press.

Fishman, B. (2005). Adapting innovations to particular contexts of use: A collaborative framework. In C. Dede, J. Honan & L. Peters (Eds.), *Scaling up success: Lessons learned from technology-based educational innovation* (pp. 48-66). New York: Jossey-Bass.

Fishman, B., Marx, R., Blumenfeld, P., Krajcik, J. S., & Soloway, E. (2004). Creating a framework for research on systemic technology innovations. *The Journal of the Learning Sciences, 13*(1), 43-76.

Fishman, B., Penuel, W. R., & Yamaguchi, R. (2006). *Fostering innovation implementation: Findings about supporting scale from GLOBE.* Paper presented at the 7th International

Conference of the Learning Sciences, Mahwah, NJ.

Frank, K. A., Zhao, Y., & Borman, K. M. (2004). Social capital and the diffusion of innovations within organizations: Application to the implementation of computer technology in schools. *Sociology of Education, 77*, 148-171.

Garet, M. S., Porter, A. C., Desimone, L., Birman, B. F., & Yoon, K. S. (2001). What makes professional development effective? Results from a national sample of teachers. *American Educational Research Journal, 38*(4), 915-945.

Kaiser, H. F. (1974). An index of factorial simplicity. *Psychometrika, 39*(1), 31-36.

Lin, H.-T., & Fishman, B. (2006). *Exploring the relationship between teachers' curriculum enactment experience and their understanding of underlying unit structures.* Paper presented at the 7th International Conference of the Learning Sciences, Mahwah, NJ.

Penuel, W., Fishman, B. J., Gallagher, L. P., Korbak, C., & Lopez-Prado, B. (2009). Is alignment enough? Investigating the effects of state policies and professional development on science curriculum implementation. *Science Education, 93*(4), 656-677.

Penuel, W. R., Fishman, B., Yamaguchi, R., & Gallagher, L. (2007). What makes professional development effective? Strategies that foster curriculum implementation. *American Educational Research Journal, 44*(4), 921-958.

Penuel, W. R., & Means, B. (2004). Implementation variation and fidelity in an inquiry science program: Analysis of GLOBE data reporting patterns. *Journal of Research in Science Teaching, 41*(3), 294-315.

Rogan, J. (2007). An uncertain harvest: A case study of implementation of innovation. *Journal of Curriculum Studies, 39*(1), 97-121.

Rogers, E.M. (1995). *Diffusion of innovations* (4th ed.). New York: The Free Press.

Roschelle, J. M., Tatar, D., Shechtman, N., Hegedus, S., Hopkins, B., Knudsen, J., et al. (2007). *Can a technology-enhanced curriculum improve student learning of important mathematics?* (SimCalc Technical Report 01) Menlo Park, CA: SRI International.

Roseman, J. E., Linn, M. C., & Koppal, M. (2008). Characterizing curriculum coherence. In Y. Kali, M. C. Linn & J. E. Roseman (Eds.), *Designing coherent science education: Implications for curriculum, instruction, and policy* (pp. 13-36). New York: Teachers College Press.

Rowan, B., & Miller, R. (2007). Organizational strategies for promoting instructional change: Implementation dynamics in schools working with comprehensive school reform providers. *American Educational Research Journal, 44*(2), 252-297.

Sarama, J., Clements, D. H., & Jacobs Henry, J. (1998). Network of influences in an implementation of a mathematics curriculum innovation. *International Journal of Computers for Mathematical Learning, 3*, 113-148.

Schmidt, W. H., & Prawat, R. S. (2006). Curriculum coherence and national control of education: Issue or non-issue? *Journal of Curriculum Studies, 38*(6), 641-658.

Schmidt, W. H., Wang, H. C., & McKnight, C. C. (2005). Curriculum coherence: An examination of US mathematics and science content standards from an international perspective. *Journal of Curriculum Studies, 37*(5), 525-559.

Spillane, J. P. (2000). Cognition and policy implementation: District policymakers and the reform of mathematics education. *Cognition and Instruction, 18*(2), 141-179.

Spillane, J. P., Reiser, B. J., & Reimer, T. (2002). Policy implementation and cognition: Reframing and refocusing implementation research. *Review of Educational Research, 72*(3), 387-431.

Velicer, W. F., & Fava, J. L. (1998). Effects of variable and subject sampling on factor pattern recovery. *Psychological Methods 3*(2), 231-251.

APPENDIX A: FULL SURVEY WITH LOGIC MAP AND SOURCES

SUMMARY OF ITEMS AND ORDER

Impact on Teaching from SimCalc Experience

1. Have you attempted to introduce changes in how you teach because of your use of SimCalc, including SimCalc professional development?
   {If yes}
   To what extent have you made each of the following changes in your teaching practices as a result of your experience with SimCalc and SimCalc professional development?

Collaboration Related to SimCalc Implementation

2. How many schools with 7th or 8th grades are in your school district?

   {More than 1 school}
   Is your district working to implement SimCalc?
   Are schools within your district working together to implement SimCalc?

3. Please indicate the types of activities your school or district employed to support SimCalc.

4. In the past year, how often have you asked *colleagues in your school* about each of the following:

5. How would you describe your SimCalc class's coverage of the student workbook?

6. Reflecting on your SimCalc professional development, to what extent was the professional development characterized by the following?

7. To what extent did the SimCalc professional development prepare you to help students do the following?

8. How useful were each of the following activities of the SimCalc PD workshop to you in preparing to teach the unit?

Support for Implementing SimCalc

9. What kinds of support did you receive for implementing SimCalc in your classroom?

Barriers to Implementing SimCalc

10. In your implementation of SimCalc, to what extent has each of the following been a barrier to implementing SimCalc with your students?

"Stick Questions"

11. Are you still using all or part of the SimCalc curriculum?
    {If yes}
    What parts of the curriculum are you still using?
    {If no}
    What are some of the reason you are no longer using the resources?

12. Were the following parts of the SimCalc Intervention useful in terms of your teaching and your students' learning and engagement?
13. What parts of SimCalc are worth sharing with other teachers?

"Spread" Questions

14. Have you discussed or shared what you learned with other teachers in your school or department *who did not* attend SimCalc professional development?
    {If yes}
    What did you discuss or share with other teachers?
15. What have you shared about your experience with SimCalc with your administrators (e.g., principal or department chair)?

SURVEY WITH LOGIC MAP AND SOURCES

ORDER	SOURCE	ITEM	VARIABLES	NOTES
1 (skip logic with following item)	EISENHOWER (PD)	**Have you attempted to introduce changes in how you teach because of your use of SimCalc, including SimCalc professional development?**	IMP_TCH	Impact on Teaching IMP = implementation TCH = teaching
		No, Yes	0, 1	
1.1 (skip logic needed with prior item)	EISENHOWER (PD)	*If you answered "yes" [on the prior question]*: **To what extent have you made each of the following changes in your teaching practices as a result of your experience with SimCalc and SimCalc professional development?** (Mark "x", one box for each line)	IMP_PRACTICE SCALE: No change =0 Minor change=1 Moderate change=2 Large change=3	Impact on Teaching IMP = implementation PRACTICE = teaching practice
		The content of the math I teach	IMP_PRACTICEA	
		The cognitive challenge of math classroom activities	IMP_PRACTICEB	
		The instructional methods I employ	IMP_PRACTICEC	
		The types or mix of assessments I use to evaluate students	IMP_PRACTICED	
		The ways I use technology in instruction (calculator or computer)	IMP_PRACTICEE	
		The approaches I take to student diversity	IMP_PRACTICEF	
2	GLOBE (96TeaSurv21)	**How many schools with 7th and 8th grades are in your school district?**	IMP_DISTRICT	
		1, more than 1 [if choose only 1 than gets a version of the next question which relates to only one district]	0, 1	
2.1.1	GLOBE (96TeaSurv21)	*[If answer "more than 1" in Question 2]*: **Are schools within your district working together to implement SimCalc?**	IMP_DIS_1	Social Interactions IMP= implementation DIS=district
		No, Yes	0, 1	
2.2.1	GLOBE (96TeaSurv21)	*{If answer "more than 1" in Question 2]:* **Are schools within your working together to implement SimCalc?**	IMP_DIS_2	Social Interactions IMP= implementation DIS=district
		No, Yes	0, 1	

ORDER	SOURCE	ITEM	VARIABLES	NOTES
3 (No skip logic)	New Item	**Please indicate the types of activities that you participated in to support your implementation of SimCalc.**	0, 1	Social Interactions COLTYP= Collaboration Type
		Mark "x" for all that apply in each column	0 if not selected	
		I attended SimCalc PD together with other teachers in our school or district.	COLTYP_1	
		I received follow-up coaching and/or mentoring to support my SimCalc implementation.	COLTYP_2	
		I participated in meetings where teachers discussed SimCalc.	COLTYP_3	
		I got paid to attend SimCalc PD.	COLTYP_4	
		Substitute teachers were provided to allow me to attend follow-up sessions for meetings with other teachers.	COLTYP_5	
		None of these apply.	COLTYP_6	
4	NETTS (05TeaSurv23)	**In the past year, how often have you asked *colleagues in your school* about each of the following.**		Social Interactions COLHLP= Collegial Help Last item (COLHLP_5) was changed significantly from source. Original asked for "ideas about how to embed GLOBE protocols within a student-led investigation"
		Mark "x", one box for each line: Never; Once or twice; About once a month; A few times a month; At least weekly	0, 1, 2, 3, 4	
		For information about which SimCalc lessons worked well with their students	COLHLP_1	
		For help in setting up and using SimCalc software	COLHLP_2	
		For ideas about how to implement a particular SimCalc lesson	COLHLP_3	
		For ideas about how keep students engaged while doing a SimCalc lesson	COLHLP_4	
		For ideas about how to embed SimCalc lessons within my curriculum	COLHLP_5	
5	Question 2 - Texteams + SimCalc "Post Unit Log"	**How would you describe your SimCalc class's coverage of the student workbook?**	IMP_COV	COV=Coverage IMP_COV2 can be something other than 0 or 1
		Mark "x" by the one which best applies	0, 1	
		We completed the entire book from start to finish.	IMP_COV1	
		We did a lot of the book, but stopped before the end, roughly on page _____.	IMP_COV2	
		If yes to IMP_COV2, this indicates the page number teachers entered.	IMP_COV2b	
		We skipped around in the book and covered only selected topics.	IMP_COV3	
		We completed the entire but used supplemental materials as well.	IMP_COV4	
		We completed the entire book but made an effort to put emphasis on the TAKS Test.	IMP_COV5	

ORDER	SOURCE	ITEM	VARIABLES	NOTES
6	GLOBE (05TeaSurvII7)	**Reflecting on your SimCalc professional development, to what extent was the professional development characterized by the following?**	PDSP_CG	PDS=structure of professional development experience 2=time 2 survey CG=congruence of professional development with teacher's context This is a measure of perceived coherence
		Mark "x", one box for each line: Not at all; Not sufficiently; Sufficiently; Very much	0, 1, 2, 3	
		Consistent with your goals for your professional development.	PDS2_CG1	
		Consistent with reform ideas within your school or department related to teaching	PDS2_CG2	
		Builds on what you learned in previous professional development experiences	PDS2_CG3	
		Designed to support district standards/ curriculum frameworks	PDS2_CG4	
		Designed to support state standards/ curriculum frameworks	PDS2_CG5	
		Designed to support state assessments	PDS2_CG6	
		Designed to integrate technology into your teaching	PDS2_CG7	
7	MathForward survey, Section 7 (classroom activity), Item 14	**To what extent did the SimCalc professional development prepare you to help students do the following?**	PDS2_RAT	PDS=structure of professional development experience 2=question 2 in this category RAT=rating of preparedness Note: PDS2RAT2.1 splits out the original PDSRAT2 between tables and graphs
		Mark one box "x" for each line: None at all; A little; A lot; A great deal	0, 1, 2, 3	
		Practice basic math facts (e.g., addition, subtraction, multiplication, and division)	PDS2RAT1	
		Read or interpret tables.	PDS2_RAT2	
		Read and/or interpret graphs	PDS2_RAT2.1	
		Make tables or graphs	PDS2_RAT3	
		Solve problems that have more than one correct answer	PDS2_RAT4	
		Solve problems in which students practice applying a method they have been taught	PDS2_RAT5	
		Describe the procedure students used to solve a problem	PDS2_RAT6	
		Explain why a procedure students used worked to solve a problem	PDS2_RAT7	
		Prove that a particular method for solving a problem is valid	PDS2_RAT8	
		Analyze similarities or differences among methods and types of problems	PDS2_RAT9	

ORDER	SOURCE	ITEM	VARIABLES	NOTES
8	GLOBE (05TeaSurvII9 [heavily modified to fit SC Texas context])	**How useful were each of the following activities of the SimCalc PD workshop to you in preparing to teach the unit?**	PDS1_AL	PDS=structure of professional development experience 1=question 1 in this category AL=active learning
		Mark "x", one box for each line: 0=I did not participate in this kind of activity; Not at all useful; Slightly useful; Useful; Very useful; 5=Essential	0, 1, 2, 3, 4, 5	
		Participated in a whole-group discussion or session	PDS1_AL1	
		Participated in a small-group discussion or session	PDS1_AL2	
		Made presentations to the group	PDS1_AL3	
		Developed a lesson plan	PDS1_AL4	
		Discussed instructional techniques	PDS1_AL5	
		Practiced using software	PDS1_AL6	
		Reviewed student work	PDS1_AL7	
		Making connections between SimCalc materials and standards	PDS1_AL8	
9	NETTS (05TeaSurv52)	**What kinds of support did you receive for implementing SimCalc in your classroom?**		Equipment for Support and Equipment Use SUPPRT=Type of Support Note: Deleted SUPPRT_G "I had contact with scientists" and added, from the logs, planned lessons with other teachers...
		Mark "x" all that apply *No, Yes*		
		I attended a professional development workshop on SimCalc at my regional service center.	SUPPRT_A	
		I talked with an outside consultant or mentor teacher skilled in SimCalc on the phone or by email.	SUPPRT_B	
		An outside mentor or consultant visited my classroom and demonstrated how to implement SimCalc.	SUPPRT_C	
		An outside mentor or consultant observed me teaching SimCalc.	SUPPRT_D	
		I received computers to use with SimCalc.	SUPPRT_E	
		I received help with setting up and using SimCalc computers and software.	SUPPRT_F	
		I planned my lessons with other teachers or discussed with other teachers how my class went either by email or in person on a regular basis.	SuPPRT_G	
		None of these apply.	SUPPRT_H	

ORDER	SOURCE	ITEM	VARIABLES	NOTES
10	GLOBE (05TeaSuvrIV3)	**In your implementation of SimCalc, to what extent has each of the following been a barrier to implementing SimCalc with your students?**	IMP_BAR	SimCalc Implementation IMP= implementation BAR= barriers
		Mark "x", one box for each line: Not a barrier; Minor barrier; Major barrier; Not applicable	0, 1, 2, 3	
		Difficulty finding time to prepare for implementing SimCalc.	IMP_BAR1	
		Difficulty completing activities within the suggested class period.	IMP_BAR2	
		Difficulty running the software on my schools' computers.	IMP_BAR3	
		Lack of technology access (my school has computers, but I could not access them.)	IMP_BAR4	
		Lack of technical support for using computers and software.	IMP_BAR5	
		Lack of computer equipment (my school does not have sufficient computers).	IMP_BAR6	
		Unsupportive school building administrators.	IMP_BAR7	
		Unsupportive district administrators.	IMP_BAR8	
		My understanding of how to implement SimCalc units.	IMP_BAR9	
		The knowledge level of my students.	IMP_BAR10	
		The interest level of my students.	IMP_BAR11	
		Lack of alignment to content tested on the TAKS.	IMP_BAR12	
		The material took too long to complete, it interfered with teaching content for the TAKS.	IMP_BAR13	
11	New Item	Are you still using all or part of the SimCalc curriculum?	STK_CUR	
		No, Yes	0, 1	

ORDER	SOURCE	ITEM		VARIABLES	NOTES
11.1 (skip logic)	New Item	*If yes to Question 11:* **What parts of the curriculum are you still using?**			STK=Sticking with using the resources CUR=curriculum
		Mark "x" for all that apply		0, 1	
		7G	Managing the Soccer Team	STK_CUR1	
			A Race Day	STK_CUR2	
			Another Race Day	STK_CUR3	
			Information Quest: How Fast?	STK_CUR4	
			Isabella Improves	STK_CUR5	
			Faster than Max	STK_CUR6	
			Practice Runs	STK_CUR7	
			Run, Jace, Run	STK_CUR8	
			Run, Jace, Run: Revisited	STK_CUR9	
			Back at the Office	STK_CUR10	
			Slope & Rate	STK_CUR11	
			On the Road	STK_CUR12	
			Road Trip Records	STK_CUR13	
			Graphs of Motion	STK_CUR14	
			Salary Negotiations	STK_CUR15	
			Summer Job Advice	STK_CUR16	
			All About MPG	STK_CUR17	
			How Far on How Much? MPG	STK_CUR18	
			Suiting Up	STK_CUR19	
			Manager's Report	STK_CUR20	
			Mathematically Speaking	STK_CUR21	
		8G	Working at TexStar Games	STK_CUR22	
			Cell Phone Games and Design	STK_CUR23	
			Yari, the Yellow School Bus	STK_CUR24	
			Our First Cell Phone Game	STK_CUR25	
			Controlling Characters with	STK_CUR26	
			Controlling Characters with	STK_CUR27	
			One to Another	STK_CUR28	
			Controlling Characters with	STK_CUR29	
			One to Another (2)	STK_CUR30	
			Better Games	STK_CUR31	
			Wendella's Journey: Moving at Difference Speeds	STK_CUR32	
			Money Matters	STK_CUR33	
			Mathematically Speaking: Graphs to Know	STK_CUR34	

ORDER	SOURCE	ITEM		VARIABLES	NOTES
		8G	Crab Velocity	STK_CUR35	
			Wolf and Red Riding Hood	STK_CUR36	
			Secrets of Average Rate Revealed	STK_CUR37	
			Problem Solving	STK_CUR38	
			Problems from the TexStar Lunchroom	STK_CUR39	
			Mathematically Speaking—Linear Relationships: Proportional and Nonproportional	STK_CUR40	
			TexStar Games: Going Full-Time	STK_CUR41	
11.2 (skip logic)	New Item	*If no to Question 10*: **What are some of the reasons you are no longer using the resources?**			NOT= Not sticking with using the resources Note1: STK_NOT14 is a string variable and contains the text the respondent wrote. This variable is coded as 999 for respondents who did not see this question. Note2: STK_NOT14_new is a variable that can take on the values 0,1 or 999 if the 'Other' option was selected or not, and 999 if the respondent didn't see this question.
		Mark "x" for all that apply		0, 1	
		Difficulty finding time to prepare for implementing SimCalc.		STK_NOT1	
		Difficulty completing activities within the suggested time period.		STK_NOT2	
		Difficulty running the software on my schools' computers.		STK_NOT3	
		Lack of technology access (my school has computers, but I could not access them.		STK_NOT4	
		Lack of technical support for using the computer and software		STK_NOT5	
		Lack of computer equipment (my school does not have sufficient computers).		STK_NOT6	
		Unsupportive school building administrators.		STK_NOT7	
		Unsupportive district administrators.		STK_NOT8	
		My understanding of how to implement SimCalc Units.		STK_NOT9	
		The knowledge level of my students.		STK_NOT10	
		The interest level of my students.		STK_NOT11	
		Lack of alignment to content tested on the TAKS.		STK_NOT12	
		The material took too long to complete, it interfered with teaching content for the TAKS.		STK_NOT13	
		Other (please specify) {See Note 1}		STK_NOT14	
		Other {See Note 2}		STK_NOT14_new	

ORDER	SOURCE	ITEM	VARIABLES	NOTES
12	New Item	**Were the following parts of the SimCalc Intervention useful in terms of your teaching and your students' learning and engagement?**		VAL=value
		Mark "x", one box each line: I don't recall; Detrimental; Not so valuable; Valuable; Very valuable	Scale: 0, 1, 2, 3, 4	
		Use of simulations in software.	STK_VAL1	
		Use of interactive graphs in software.	STK_VAL2	
		The curriculum materials.	STK_VAL3	
		The planned timetable of the lesson.	STK_VAL4	
		Individual students or pairs of students having their own computer to work on.	STK_VAL5	
		Students working in pairs or as part of a group.	STK_VAL6	
		Curriculum in conjunction with the software.	STK_VAL7	
		Alignment with the TAKS test and Texas State Standards.	STK_VAL8	
13	New Item	What parts of SimCalc are worth sharing with other teachers?		IMP=perceived importance Note 1: From the post unit log 7GY1 Treatment; also mentioned by 8G teachers
		Mark "x", one box each line: I don't recall; Least important; Not so important; Important; Most important	Scale: 0, 1, 2, 3, 4	
		Use of simulations in software.	STK_IMP1	
		Use of interactive graphs in software.	STK_IMP2	
		The curriculum materials.	STK_IMP3	
		Manipulating/using the software. {See Note 1}	STK_IMP4	
		The essay/writing components of the curriculum materials.	STK_IMP5	
		The reaction and participation of students to the curriculum and software.	STK_IMP6	
		If using the 7th grade unit, the "On the Road" activity.	STK_IMP7	
		If using the 8th grade unit, the "Wendella's Journal" activity.	STK_IMP8	
		If using the 7th grade unit, the "Slope and Rate" activity.	STK_IMP9	
		If using the 8th grade unit, the "Texas Road Rally" activity.	STK_IMP10	

ORDER	SOURCE	ITEM	VARIABLES	NOTES
14	GLOBE (05TeaSurv11)	**Have you discussed or shared what you learned with other teachers in your school or department** *who did not* **attend SimCalc professional development?**	IMP_TCH	SPR= spread of using software SHR= sharing outside of PD
		No, Yes	0, 1	
14.1 (skip logic)	New Item	*If yes to Question 14*: **What did you discuss or share with other teachers?**	SPR_IMP	IMP= important reason for sharing Note 1: SPR_IMP7 is a string variable that contains the text written by the respondent. This is coded as 999 if the respondent didn't see this question because the skip logic Note 2: SPR_IMP7_new is coded as 0, 1 or 999 depending on if they did not select this option, they did select it or they didn't see it.
		Mark "x" on all that apply	0, 1	
		The use of technology in the classroom.	SPR_IMP1	
		The use of content contained in activities.	SPR_IMP2	
		Important to teach the content contained in the activities.	SPR_IMP3	
		Engagement of student learning.	SPR_IMP4	
		Increase in student motivation	SPR_IMP5	
		Ability to encourage students to verbalize their reasoning, analyze mistakes and engage in dialogue.	SPR_IMP6	
		Other (Please specify) {See Note 1}	SPR_IMP7	
		Other {See Note 2}	SPR_IMP7_new	
15	New Item	What have you shared about your experience with SimCalc with your administrators (e.g., principal or department chair)	SPR_ADM	ADM= administrators Note 1: SPR_ADM6 is a string variable Note 2: SPR_ADM6_new is coded as 0, 1 or 999 if the respondent did not choose this option, chose it or didn't see it because of skip logic or they did not complete the survey.
		Mark "x" on all that apply	0, 1	
		The technology	SPR_ADM1	
		Information on student outcomes	SPR_ADM2	
		Impact on student engagement/motivation	SPR_ADM3	
		Free materials	SPR_ADM4	
		SimCalc/SRI Website	SPR_ADM5	
		Other (Please specify) {See Note 1}	SPR_ADM6	
		Other {See Note 2}	SPR_ADM6_new	

APPENDIX B: RATIONALE FOR SURVEY ITEMS TO BE INCLUDED IN SCT INDEX

Question	Variable	Respons	Rationale
Question 1.1: **To what extent have you made each of the following changes in your teaching practices as a result of your experience with SimCalc and SimCalc professional development?**	IMP_PRACTICEC - **The instructional methods I employ**	Desirable response: 2 or 3 (high)	This question-variable-response (QVR) was selected because the exposure to SimCalc and correct SimCalc methods and practice via PD had an impact, as perceived by the responder, to be a large change. This indicates a change in pedagogical methods because of SimCalc. Presumed positive.
Question 1.1: **To what extent have you made each of the following changes in your teaching practices as a result of your experience with SimCalc and SimCalc professional development?**	IMP_PRACTICEE- **The ways I use technology in instruction (calculator or computer)**	Desirable response: 2 or 3 (high)	This indicates a change in pedagogical methods with respect to technology in the classroom, due to the exposure to SimCalc. Presumed positive.
Question 5: **How would you describe your SimCalc class's coverage of the student workbook?**	IMP_COV1 - **We completed the entire book from start to finish.**	Desirable response: 1 (yes)	This indicates a belief that he curriculum was coherent and aligned with standards and frameworks required by TAKS. It also indicates that supplemental material is not needed and completion of the materials is fundamental.
Question 6: **Reflecting on your SimCalc professional development, to what extent was the professional development characterized by the following?**	PDS2_CG1 - **Consistent with your goals for your professional development**	Desirable response: 2 or 3 (high)	The exposure to SimCalc & PD is believed by the responder to be aligned with their advancement as a teacher.
Question 6: **Reflecting on your SimCalc professional development, to what extent was the professional development characterized by the following?**	PDS2_CG7 - **Designed to integrate technology into your teaching**	Desirable response: 2 or 3 (high)	The exposure to SimCalc & PD is believed by the responder to assist in bringing technology and teaching together in their classroom.
Question 7: **To what extent did the SimCalc professional development prepare you to help students do the following?**	PDS2RAT4 - **Solve problems that have more than one correct answer**	Desirable response: 2 or 3 (high)	SimCalc PD changed the mindset of the responder to be better prepared and more open to the possibility of more than one correct answer. Often, the opposite is true with traditional methods, materials and textbooks.
Question 7: **To what extent did the SimCalc professional development prepare you to help students do the following?**	PDS2RAT7 - **Explain why a procedure students used worked to solve a problem**	Desirable response: 2 or 3 (high)	What was learned during training and use of SimCalc effected the responders ability to coherently explain varying procedures produced by students back to all students in a way they would understand.

Question	Variable	Response	Rationale
Question 8: **How useful were each of the following activities of the SimCalc PD workshop to you in preparing to teach the unit?**	PDS1_AL1 - **Participated in a whole-group discussion or session**	Desirable response: 3, 4 or 5 (high)	The responder finds that group dynamics are beneficial to the correct implementation of SimCalc.
Question 8: **How useful were each of the following activities of the SimCalc PD workshop to you in preparing to teach the unit?**	PDS1_AL2 - **Participated in a small-group discussion or session**	Desirable response: 3, 4 or 5 (high)	The responder finds that group dynamics are beneficial to the correct implementation of SimCalc.
Question 8: **How useful were each of the following activities of the SimCalc PD workshop to you in preparing to teach the unit?**	PDS1_AL5 - **Discussed instructional techniques**	Desirable response: 3, 4 or 5 (high)	The responder finds that group dynamics are beneficial to the correct implementation of SimCalc.
Question 8: **How useful were each of the following activities of the SimCalc PD workshop to you in preparing to teach the unit?**	PDS1_AL6 - **Practiced using software**	Desirable response: 3, 4 or 5 (high)	The responder finds that group dynamics are beneficial to the correct implementation of SimCalc.
Question 8: **How useful were each of the following activities of the SimCalc PD workshop to you in preparing to teach the unit?**	PDS1_AL8 - **Making connections between SimCalc materials and standards**	Desirable response: 3, 4 or 5 (high)	The responder finds that group dynamics are beneficial to the correct implementation of SimCalc.
Question 12: **Were the following parts of the SimCalc Intervention useful in terms of your teaching and your students' learning and engagement?**	STK_VAL1 - **Use of simulation in software**	Desirable response: 3 or 4 (high)	Considering this is one of the fundamental aspects of SimCalc it should be believed by the responder that this is valuable.
Question 12: **Were the following parts of the SimCalc Intervention useful in terms of your teaching and your students' learning and engagement?**	STK_VAL2 - **Use of interactive graphs in software**	Desirable response: 3 or 4 (high)	Considering this is one of the fundamental aspects of SimCalc it should be believed by the responder that this is valuable.
Question 12: **Were the following parts of the SimCalc Intervention useful in terms of your teaching and your students' learning and engagement?**	STK_VAL3 - **The curriculum materials**	Desirable response: 3 or 4 (high)	Considering the curriculum was aligned to standards and designed for the software, a responder should find high value in the curriculum/software.
Question 12: **Were the following parts of the SimCalc Intervention useful in terms of your teaching and your students' learning and engagement?**	STK_VAL6 - **Students working in pairs or as part of a group**	Desirable response: 3 or 4 (high)	Considering a favored, or intentional aspect of the curriculum made for SimCalc has students creating and exploring on their own, as opposed to a demonstration, the responder should find high value in this.
Question 12: **Were the following parts of the SimCalc Intervention useful in terms of your teaching and your students' learning and engagement?**	STK_VAL7 - **Curriculum in conjunction with the software**	Desirable response: 3 or 4 (high)	Considering the curriculum was designed for use with the software, and for their standards, the user should find high value, and believe there is a connection between the software and curriculum.

LEGEND—SOURCE IN THE LOGIC MAP

GLOBE =

Penuel, W. R., Fishman, B., Yamaguchi, R., & Gallagher, L. (2007). What makes professional development effective? Strategies that foster curriculum implementation. *American Educational Research Journal, 44*(4), 921-958.

EISENHOWER =

Garet, M. S., Porter, A. C., Desimone, L., Birman, B. F., & Yoon, K. S. (2001). What makes professional development effective? Results from a national sample of teachers. *American Educational Research Journal, 38*(4), 915-945.

NETTS =

Means, B., Murphy, R., Javitz, H., Haertel, G., & Toyama, Y. (2004). *Design considerations for evaluating the effectiveness of technology-related teacher professional development*. Menlo Park, CA: SRI International.

Sponsor: National Science Foundation, Grant No. REC-0437861

Prime Grantee: SRI International, Menlo Park, CA, USA

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

University of Massachusetts Dartmouth
Kaput Center for Research and Innovation in STEM Education
200 Mill Road, Suite 150B
Fairhaven, MA 02719
774-929-3065