

Computer Use and Pedagogy in Co-NECT Schools,  
A Comparative Study

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Teaching, Learning, and Computing: 1998 National Survey

Special Report

University of California, Irvine

December, 1999

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In the spring of 1998, researchers at the University of California, Irvine and the University of Minnesota conducted a national survey of teachers' pedagogy and use of computers. The Teaching, Learning, and Computing (TLC) survey, funded by the National Science Foundation and the U.S. Department of Education, included, among the more than 4,000 teachers and 1,100 schools participating, a total of 21 teachers from 6 schools that were among the first to participate in the Co-NECT Schools program of whole-school, technology-infused reform. This special report from the TLC study focuses on characterizing these early Co-NECT teachers in comparison with several other groups of teachers who participated in the national survey. Although the sample of Co-NECT teachers is quite small, the schools and teachers fairly well represent the types of schools and the diversity of teachers who had begun participating in Co-NECT by the 1997-1998 school year. We believe that the comparisons drawn between these teachers at Co-NECT schools and teachers at other schools (e.g., "high-end technology schools with no particular reform emphasis"; "schools involved in school-wide reform that do not emphasize computers"; or "nationally representative schools serving students from low socio-economic backgrounds") are suggestive of ways that Co-NECT schools function differently from other environments for teaching.

## **THE TEACHING, LEARNING, AND COMPUTING: THE 1998 SURVEY**

The TLC study was conducted to investigate the conditions under which teachers' use of computers is related to teaching practice consistent with instructional reform theories. The study is comprised of completed questionnaire responses from classroom teachers of grades 4 through 12, principals, and school technology coordinators from three separate samples of schools: a national probability sample, a sample of schools with high-end per capita amounts of computer technology, and a sample of schools participating in one of 54 major national or regional programs that emphasize instructional reform. In the 75% of these schools that agreed to participate (1,215 schools), between 3 and 7 teachers were sampled for participation. Of the teachers rostered and selected, a total of 4,083 teachers returned completed surveys, or 68% of those selected. At both school and teacher level, unequal probabilities were used to select participants, with the goal of gathering more detailed information about the "upper-end" of technology use and reform instructional practices. However, all analysis weights cases inversely to the likelihood of each person or school being selected, in order to more closely reflect data that would be obtained from equal-probability representative samples. Additional information about sampling is included in Appendix A.

The 21 participating teachers from Co-NECT schools include teachers from 2 elementary schools (Alton in Memphis and Kilgour in Cincinnati), 3 middle schools (The Accelerated Learning Laboratory in Worcester, MA; and Horace Mann and Riviera in Miami), and 1 high school (Hughes Center, in Cincinnati). The teachers are almost equally divided among elementary (7), middle (8), and high school (6) levels and the secondary teachers included those specializing in English, social studies, science, math, computers, fine arts, and other applied and academic areas. Using the weights employed for all analyses, 15% of the Co-NECT teachers served elementary schools (5 percentage points less than in the total weighted sample), 22% were primarily English teachers, 27% primarily taught science or social studies, 11% were mathematics teachers, and 26% primarily taught other subjects or a mix of

secondary subjects. Five of the six Co-NECT schools (and 95% of the weighted teachers) served students from schools in the lowest quartile on our measure of socio-economic-status.

Co-NECT schools can be characterized as schools involved in a thoroughgoing program of whole-school reform, one that involves substantial use of computer technology in pursuit of student learning that is project-based, interdisciplinary, and emphasizes authentic, real-world applications of academic content and community service. Additional information about Co-NECT schools can be found in Stringfield, Ross, and Smith, Bold Plans, 1996; and on the Co-NECT website, <http://www.co-nect.org>.

For purposes of this report, we have defined several comparison groups that are useful in distinguishing how Co-NECT teachers are different from or similar to other teachers. These include teachers from:

- High-Technology Presence settings or (High-end Technology Schools) that are not part of any particular reform program (362 teachers);
- School-wide Technology-Oriented Reform Programs (besides Co-NECT) such as the National School Network and Schools for Thought as well as schools with an early presence on the World Wide Web suggesting substantial technology-based reform (232 teachers);
- School-wide Reform programs that are not technology-oriented such as Accelerated Schools, National Alliance for Restructuring, Coalition for Essential Schools, and Paideia Schools (605 teachers);
- Technology reform programs that target individual teachers rather than whole schools, such as Co-VIS, HOTS, Learning Circles, and individual programs identified through a variety of sources including Serim's, "NetLearning" (51 participating teachers and 232 non-participants).
- The national probability sample of schools (2,251 teachers);
- Schools in the lowest quartile of the national probability sample in terms of student socio-economic status (476 teachers);

In our analysis of Co-NECT schools, we investigated several issues about computer use and teaching pedagogy including teachers' access to technology resources, their frequency of computer use, instructional objectives for using computers, teacher computer expertise, teaching philosophy and instructional practices without reference to computers, changes in pedagogy they have made over the past several years, their perception of the impact of computers on those changes in pedagogy, their own orientation to the teaching role (teacher leadership vs. their own classroom instruction), and school context (opportunities for learning, teacher culture, and pressures to teach in certain ways). In this report, we will compare teachers in Co-NECT schools to teachers in other types of schools in each of these areas.

## TEACHER-DIRECTED COMPUTER USE

### Access to Technology Resources

Co-NECT teachers were much more likely than any other group of teachers studied to report having a substantial number of computers in their own classroom. Nearly one-half of Co-NECT teachers (47%, weighted), by Spring, 1998, had at least one computer for every four students in their classroom, a percentage not approached by any other group of teachers studied, including the teachers in technology-oriented reform programs that recruit teachers on an individual basis (28%). For all other groups of teachers, fewer than one fifth could report having this number of computers available in their own classroom. (See Figure 1)

In terms of access to the Internet, three-quarters of Co-NECT teachers had at least a modem connection in their classroom, and, compared to other groups, Co-NECT teachers were most likely to have the highest level of connectivity of all—a high-speed (non-modem) direct connection for at least 4 computers in their room (18%, as of Spring, 1998). (See Figure 2)

In addition to these important aspects of technology access, Co-NECT teachers were more likely than others were to have computers available for home borrowing and to have home access to the school's computer network. However, in some other areas, they were not particularly advantaged—such as having telephones in their classroom, having access to a fax machine, and having a computer available for their own dedicated use while at school.

### Frequency of Computer Use

Frequent use of computers is a necessary, though hardly a sufficient, condition for important technology-based teaching. TLC measured several aspects of computer use, including how frequently teachers arranged for a “typical student” to use computers during class time and how often they had students use certain kinds of software. In terms of frequent overall student computer use, Co-NECT teachers are much more likely than teachers in other schoolwide technology-oriented reform programs to report frequent (twice-weekly) use (40% of Co-NECT teachers vs. under 20% of teachers in other schoolwide technology programs). (See Figure 3) They are also much more likely than teachers who teach in High-End Technology schools (schools with a great deal of technology but no particular reform program) to report that level of use. In fact, schoolwide, Co-NECT teachers are as likely to report having students use computers frequently as are the individually recruited teacher participants in technology-based reform programs which focus on individual teacher reformers rather than attempting whole-school reform. With Co-NECT, one sees, at least in this small sample, on a schoolwide basis a level of technology use that is achieved only by individual program participants—almost never achieved on a schoolwide basis in other settings, either those with an emphasis on reform or those with high density technology presence.

Computers, of course, can be used in many different ways for many different purposes. Like teachers in other groups of schools, Co-NECT teachers had students use word processing more than any other type of software; in fact, their use of word processing was not

substantially greater than teachers' use of that type of software in other school settings. However, Co-NECT teachers had students use five types of software substantially more than other teachers: spreadsheet/database software, the World Wide Web, presentation software, electronic mail, and multimedia authoring. In particular, Co-NECT teachers used multimedia authoring software eight times as much as teachers in the national probability sample. Other technology-emphasizing teachers and schools also used multimedia authoring more than the national sample, but none came close to the level of use of that type of software (exemplified by the application called Hyperstudio) found among these 21 Co-NECT teachers. As a point of contrast, although Co-NECT teachers also had students use electronic mail much more than the teachers in the national sample (about three times as much), the individual participants in technology-based reform programs at other schools emphasized student e-mail even more than did Co-NECT teachers—almost twice as much. (See Figure 4)

### Objectives for Computer Use

The pedagogical role that technology plays in teachers' practices can be seen in the "objectives" that each teacher claims for their use of computers. The TLC survey asked those teachers who used computers with the class they taught in which they felt "most satisfied with your teaching" to select their three most important objectives for computer use in that class. Like most computer-using teachers, Co-NECT teachers often reported wanting students to find out about ideas and information through the use of computer applications such as CD-ROMs and the World Wide Web and to express themselves in writing through their use of word processors and other software.

They did differ from other groups of computer-using teachers, however, in that 50% of the Co-NECT teachers selected "presenting information to an audience" as a primary objective while only 18% of teachers in the national sample did, and no other group of teachers studied exceeded 30% on this objective. (See Figure 5) Similarly, they were more likely than other teachers to report "learning to work collaboratively" as an objective for their students' computer use (53% vs. about 25% nationally). Co-NECT teachers were particularly distinctive in these more "constructivist" objectives for computer use in comparison to teachers in low-income schools. For example, in the low-SES portion of the TLC national sample, only 13% of computer-using teachers named "presentation to an audience" as a principal objective and only 18% named "learning to work collaboratively," one-third to one-fourth the rate such objectives were found among Co-NECT teachers. (See Figure 6)

In contrast, Co-NECT teachers were less likely than other computer-using teachers to be interested in some of the strictly skill related objectives in the survey such as improving computer skills, mastering basic academic skills, and remediation of skills previously taught, and to emphasize individual knowledge acquisition as opposed to collaborative learning. They were particularly less likely to emphasize skill-based objectives or "learning to work independently" than were teachers in the low-SES national probability sample, even though 95% of the responding Co-NECT teachers (weighted) fell into the bottom quartile on school socio-economic-status. Nationally, teachers in low-SES schools were between two- and three-times as likely to name skill mastery objectives as Co-NECT teachers and more than

three times as likely to say that improving students' abilities to work independently was a principal goal of using computers (27% vs. 8%). (See Figure 6)

An unexpected finding, given the preceding results, was that Co-NECT teachers were also less likely than others to report "analyzing information" as a primary objective of their use of computers. (See Figure 7) Although only 10% of Co-NECT teachers chose this objective among their top three, 42% of computer-using teachers in schools involved in other schoolwide technology reform programs did and a remarkable 57% of individual technology program participants. Even 27% of teachers in the national probability sample gave this choice as well.

However, some part of the explanation for this finding is the low socio-economic background of the students Co-NECT teachers serve. Teachers in schools serving primarily students from low socio-economic backgrounds are much less likely than teachers in other schools to name "analyzing information" as a purpose of giving students opportunities to use computers; conversely, teachers in high-SES schools, like many of those in which individual program participants work, are generally more likely to think in terms of "analyzing information" as a goal of student computer use. Still, even among the national sample of low-SES schools (the bottom quartile in the national probability sample), more computer-using teachers in that comparison group reported analysis of information as a primary objective of computer use than in the Co-NECT schools (17% vs. 10%). Co-NECT schools' overall pattern of emphasizing active student work through multimedia authoring projects with the objective of presenting student work before an audience seems to have driven out technology-related instruction that focuses on critical evaluation and analysis of information and ideas.

### Use of Computers for Class Work Outside of Class Time

An important indicator of student engagement in school work is the extent that they continue to work on academic tasks outside of class time—outside of the direct supervisory presence of teachers. We believe it is highly informative that teachers with objectives similar to those of Co-NECT teachers (presenting information to an audience, expression in writing, communicating with other people, and finding out about ideas and information) were more likely than teachers with different objectives to report that their students are doing work on computers for class, outside of class time. Although Co-NECT teachers do report students to be doing class work on computers outside of class time more often than the Low SES comparison group, their students' lack of computers at home places them slightly below other groups of reform-involved teachers or high technology schools in this overall measure of out-of-class computer use. However, when we break down the reported out-of-class use to that which occurs at school (before and after school, at lunch) versus that which occurs at home, Co-NECT teachers report more in-school out-of-class computer use than any other comparison group, including the high-end technology schools and other schoolwide reform programs. (See Figure 8)

## Professional Use of Computers by Teachers

Overall, Co-NECT teachers use computers themselves, for professional purposes, slightly more than teachers in the national probability sample and substantially more than teachers in low-SES schools, nationally. (See Figure 9) However, they use computers professionally less than teachers in high-end technology schools or teachers in other schoolwide reform programs. However, the particular ways that Co-NECT teachers do or do not use computers suggests a more sophisticated pattern than other groups of teachers. They are more likely than others, even than teachers in other schoolwide reform or high-tech schools, to use computers for corresponding with parents, exchanging files with other teachers, and posting suggestions or student work on the World Wide Web. They are less likely than other groups to use computers to record student grades, make handouts, or write lesson plans. It may be that Co-NECT teachers place lower importance on some fairly common professional tasks, and that this causes them to appear to be less frequent professional users of computers.

## Teacher Computer Expertise

Co-NECT teachers appear to have more personal computer expertise than each of the other comparison groups of teachers except one—the participants in individually-recruiting technology-based reform programs. Co-NECT teachers report more expertise than even those selected individual program participants on one skill—developing a multimedia document—but on most of the other computer competencies we asked about, such as creating a database and establishing screen layouts, imbedding graphics into a word processor file, and preparing a slide show, the Co-NECT teachers’ skills are somewhat above average, but not remarkable. (See Figures 10 and 11) Moreover, on two other measures of expertise, the Co-NECT teachers as a group rank the highest of all comparison groups, including the individual technology program participants. First, the proportion of Co-NECT teachers who report being either “expert” on one computer platform or “very experienced” on two is more than any other comparison group. (See Figure 12) And second, Co-NECT teachers are long-time home computer users. They are more than twice as likely as most groups and 20 percentage points more likely than the individual technology program participants to have had a computer at home for more than a decade. (See Figure 13)

## TEACHING PHILOSOPHY AND PEDAGOGY

### Model of Instructional Reform

The primary goal of the Teaching, Learning, and Computing study is to investigate the relationship between teachers’ use of computers and their basic pedagogical philosophies and practices. In particular, we are studying teaching from the perspective of a model of constructivist-compatible instructional reform. The model has two elements.

#### “Meaningfulness” as a Primary Attribute of Student Activity

The first aspect of our reform model emphasizes the importance of making “meaningfulness” the primary attribute of learning tasks. (See Figure 14) Meaningfulness is the central attribute of constructivist theories of learning. To make concepts meaningful requires that tasks be rich in variety and detail, regarded as important and interesting by the learner, and related to other

ideas that the learner holds. Meaningful instruction can be accomplished by engaging students in such tasks as complex group projects occupying many days' work, tasks involving real-world situations about which students can be expected to have a prior interest, and tasks that are defined by students themselves or for which a great deal of latitude is given in how they might be accomplished. Classrooms built around such tasks tend to look different: students may be given leadership roles or take independent initiative that might not normally be available in more traditional classrooms. Prioritized subject-matter content and skills are to be taught in the context of students doing work that is meaningful to them. However, many constructivist-oriented reformers regard the idea of a completely defined curriculum taught uniformly in all classes of a given age and subject as less important than assuring that students build a variety of learning-related competencies through continued engagement in meaningful tasks.

### Teaching for Understanding

The second major aspect of our reform model emphasizes learning goals encompassing critical thinking, problem solving, and deep understanding of content. (See Figure 15) It stresses that teachers should pose intellectually challenging problems and encourage students to arrive at their own conclusions through thinking and through discourse with others. Aspects of that process include having students articulate their reasoning about issues, work at improving their written and other work until it meets higher standards of quality that they endorse, engage in discourse with peers about substantive questions and in order to make collective decisions, and frequently reflect on their own levels of understanding of an issue. Classrooms organized for these goals will be classrooms rich in information and other resources and where a mindset for thinking and learning is established by the teacher, in part through modeling the behavior expected in students. Classroom structures and roles tend to change, as does the form that assessment of student work takes. Rather than measuring students' knowledge of a predetermined set of discrete facts, assessment facilitates helping both teacher and student understand how deeply students understand an issue and how effectively they work at continued learning.

To what degree do Co-NECT teachers and other teachers reflect these kinds of pedagogies? We separate this question into two parts: To what extent are teachers' philosophies or "beliefs about good teaching" reflective of the elements of the above model? And to what extent is their actual teaching practice reflective of those elements?

### Teaching Philosophy

In order to measure the extent to which different teachers' philosophies are consistent with reform models, we created two indices of teacher beliefs: one concerning beliefs about how instruction should proceed so that students gain knowledge and, the other, beliefs about how classrooms should be managed. We will use only the first of these indices in this presentation, the Index of Constructivist Teaching to Facilitate Knowledge Development.

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### Index of Constructivist Teaching to Facilitate Knowledge Development

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- Teacher believes in being facilitator rather than explainer
  - Instruction should be built around more complex problems, not problems with clear, correct answers
  - Students should help establish the criteria on which their work is assessed
  - Teachers know more and shouldn't let students muddle around (reversed)
  - Student learning depends on background knowledge – that's why teaching facts is so necessary (reversed)
  - Student interest and effort more important than textbook content
  - Better for teacher, not students, to decide what activities are to be done (reversed)
  - Sense-making and thinking are most important, not knowing content
- 

On this measure of philosophy supporting constructivist knowledge facilitation, the teachers with the highest mean score were the individual participants in technology-based reform programs that target individual teachers. Although teachers in Co-NECT schools had substantially lower scores on that index than the individual program participants, as a group they had a higher score than any of the other groups compared. (See Figure 16)

On several individual survey items, Co-NECT teachers reported more constructivist philosophies than any other group, including the individual program participants. For example, none of the Co-NECT teachers agreed with the traditional idea that “teachers know a lot more than students; they shouldn't let students just muddle around when they can just explain the answers directly.” This suggests that the large majority of Co-NECT teachers value students undergoing a serious thought process on their own, even if they do arrive at the wrong answer. Reform theory emphasizes the importance of students learning the process of deducing or constructing knowledge just as much as learning the content itself. In the constructivist view, the student's personal construction of knowledge is essential for real understanding. Co-NECT teachers were also the least likely of any group to agree with the idea that “instruction should be built around problems with clear, correct answers, and around ideas that most students can grasp quickly.” Overall, nationally 38% of teachers agreed with this; but in the weighted Co-NECT sample, only 2% did. (See Figure 17) The only other group of teachers close to suggesting as constructivist a philosophy as Co-NECT teachers on these two items were teachers participating in programs targeting individuals.

Another questionnaire item, not shown in the accompanying figures, posed two contrasting views of the role of the teacher in the classroom and asked teachers to select, on a five point continuum, where they placed themselves in relation to these two roles. The first role of the teacher was described as a classroom “facilitator.” In this capacity, the teacher merely provides the opportunities and resources students need to construct knowledge on their own. The alternative role posed was the teacher acting as an “explainer.” The explainer believes that students won't learn subject material unless the teacher goes over concepts in a structured way. They feel it is their job to show students how to do the work and to assign specific practice. Although, overall, the individual program participants were the group most likely to view themselves as facilitators (51%), Co-NECT teachers were among those also leaning toward that side (42%), and were clearly less likely than others to see themselves as

explainers. Less than one fifth of both Co-NECT teachers and individual participants saw themselves in the explainer role compared to 29% of the national sample, 33% of the low-SES national sample, and as many as 48% of the non-participants in schools where a participant participated in a technology-oriented reform program.

Co-NECT teachers' response to the teaching styles of one traditional teacher and one constructivist teacher also indicated that Co-NECT teachers hold more constructivist beliefs than most. Ms. Hill was the traditional teacher presented in the example. She led her class in an animated way, asking questions that students could answer quickly. Questions were based on the reading students had done the day before. After this review, Ms. Hill taught the class new material, again using simple questions to keep students attentive and listening to what she said. Mr. Jones demonstrated another approach to leading class discussion. Many of the questions asked during class came from the students themselves rather than from the teacher. Though Mr. Jones could clarify students' questions and suggest where the students could find relevant information, he couldn't really answer most of the questions himself. Mr. Jones' approach to teaching is consistent with models of reform that state that children are able to construct knowledge for themselves based on their own curiosity and experiences rather than being told by the teacher what constitutes knowledge. More than other teachers except for individuals targeted by programs, Co-NECT teachers disagreed that the approach of Ms. Hill provided students with better knowledge. (See Figure 18) A majority of Co-NECT teachers (56%) also reported that they were actually more comfortable teaching in the style of Mr. Jones over that of Ms. Hill. Meanwhile, the majority of all other comparison groups reported they were more comfortable with the style of Ms. Hill. (See Figure 19)

On other items however, Co-NECT teachers' beliefs about learning appeared more traditional. More than other teachers, they believe in the usefulness of multiple choice or short answer questions, they believe that the teacher and not the student should decide on what activities are to be done, and that background knowledge and facts are essential for learning. 55% of Co-NECT teachers believe that multiple-choice and short answer questions are very useful compared to fewer than 38% of any other group including the national sample. (See Figure 20) A full three quarters of Co-NECT teachers agreed that teachers should decide on activities, not students. Meanwhile only between 50% and 55% of teachers in most other groups agreed with the statement. Co-NECT teachers more than any other group agreed that background knowledge and facts are essential for learning. In fact almost 70% of them agreed compared to between 40% and 51% of other teachers with the exception of the Low SES national sample, 59% of whom agreed with statement. (See Figure 21)

While many other teachers and programs have given up on more constructivist approaches to teaching low SES students arguing that such approaches are only successful for students with academic backgrounds strong enough to benefit from such freedom, Co-NECT teachers maintain a constructivist approach among their students. Their beliefs about schooling and society may reveal why they hold to such a pedagogy. Co-NECT teachers hold more pessimistic views about un-prepared lower class kids entering society. Only 20% of Co-NECT teachers felt that the economy is strong enough to absorb all students from school into society while approximately half of other teachers hold this belief. (See Figure 22) This is perhaps why Co-NECT teachers measure their students against the same standards as other

teachers do with higher SES student populations. They expect accomplishment beyond mastering skills tested by the state. They work to engage their students in meaningful work and asked students to take real responsibility – work that will prepare them to tackle diverse problems rather than training them to pass specific tests.

### Teacher Pedagogy

In practice, we find that Co-NECT teachers are more constructivist than other teachers in that they spend more time allowing students to lead class discussion and do group work. They also focus more in depth on issues more than other teachers rather than superficially covering a breadth of knowledge. Co-NECT teachers are also more constructivist in that they are the group least likely to ask students for “correct” answers and do less seatwork with textbooks and worksheets than teachers in other comparison categories. We will examine each of these items below.

In order to measure teacher practice, TLC asked teachers to report on the activities that had gone on in the last 5 hours of their class. Co-NECT teachers spent the most time having students do group work and were much more likely than other teachers to report that their students had worked on small group assignments for at least 1 of those 5 hours. Almost 80% of Co-NECT teachers reported that this was the case compared to about half of other teachers in other comparison groups. (See Figure 23) The other activity where Co-NECT teachers stood out from the rest are in the high percentages that had students leading class discussions for more than 1 of the 5 hours. Again, despite expressed beliefs about the importance of teacher defined activities, in practice, Co-NECT teachers allow students to determine the course of class discussion more than other teachers. In fact 30% of Co-NECT teachers reported that students led class discussion for 1 hour or more compared to less than 17% of other teachers. (See Figure 24) Although not part of the “last 5 hours” question, in a related item Co-NECT teachers were shown to be much less likely have students doing seatwork using a textbook or worksheet than other teachers were. Only 5% of Co-NECT teachers reported having students to seatwork on a weekly basis, whereas all other groups were in the 35-65% range. Particularly interesting is that nearly two-thirds (63%) of the low-SES national sample teachers reported weekly use of seatwork, more than 12 times the percentage of Co-NECT teachers who did so, serving essentially similar students. (See Figure 25)

Examination of other questionnaire items also indicate that Co-NECT teachers are really having students explore issues in depth rather than limiting students’ thought to simple questions with fast and easy answers. One questionnaire item asked teachers if they are often interested in seeing whether students knew the “correct answers” to questions. Only 23% of Co-NECT teachers reported that they often sought correct answers compared to more than 45% of other teachers with the exception of individuals participating in technology programs who were like Co-NECT teachers in that respect. (See Figure 26) TLC attempted to measure whether teachers were covering a broad breadth of topics or whether they were focusing on fewer issues in depth by asking teachers whether they covered a very large number, a large number, but covered in some depth, a moderate number covered in depth, or a small number covered in great depth. Once again, Co-NECT teachers stood out from the rest. They report the fewer topics covered in greater depth (score of 3.2 vs. 2.5 or 2.6 among other teachers on

that index) and are allowing students to develop a deeper understanding of content rather than attaining superficial knowledge. (See Figure 27)

## Broad Categories of Practice Examined

Just as the analysis of teachers' philosophies found two distinct dimensions related to constructivist versus traditional practice, our examination of teacher practice found several distinct types of activities that appear to engage students in the type of knowledge construction or learning described by reform models. These activities include reflective writing, divergent thinking, problem-solving, and project based activities. We created indices for each of these types of activities from relevant items in the teacher questionnaire (See Figure 28) and found that the 21 teachers in Co-NECT schools had the highest average score on all of them except for problem solving. Each dimension of teacher practice is discussed below.

### Reflective Writing

The Co-NECT teachers did more reflective writing than any other group. By reflective writing we mean writing used by students to seriously assess their own work, essays where students explaining their thinking or reasoning at length, or students writing in a journal. Not far behind Co-NECT teachers on our reflective writing index were individuals participating in individual technology reform programs, surprisingly, the Low SES national sample, and the school-wide non-technology reform programs. (See Figure 29; note that this and the next several figures use z-score transformations of these indices, using the national probability sample as the reference point.)

### Divergent Thinking

Co-NECT teachers also score higher than any other group on the divergent thinking activities index which measures how often students debate a point of view that is not their own, perform tasks with no "correct" answer (problems that concern complex truths), discuss topics in small groups when a unit is introduced, and represent ideas in more than one way (e.g. table/poem/graph/essay). (See Figure 30) Though the score for Co-NECT teachers on the overall index is close to at least double the score of any other comparison category, they score higher on some items in the index than others. For example, though Co-NECT teachers far outscore other teachers on having students present multiple representations of the same idea, they have students perform tasks with no "correct" answer only slightly more frequently than most (with the exception of the individuals targeted for reform). As for another component of the divergent thinking index - having students debate points of view other than their own, though teachers rarely have students perform this activity, Co-NECT teachers do so even less often than all other comparison categories. (See Figure 31)

### Projects

In terms of having students do projects, Co-NECT teachers again are more likely to report that their students perform project-based activities more than any other group. We attempted to

make our project index fairly stringent by considering the duration of the project and meaningful uses of the resulting product of the task. Our index was based on how often students do projects that take week or more, make products that will be used by someone else, perform hands on laboratory activities, and demonstrate their work to an audience other than their school or their family. (See Figure 32)

### Problem Solving

Our problem solving index was based on how often students, on their own, decide on procedures for solving a complex problem and then discuss among themselves their different procedures and results, how often they work in small groups to come up with a joint solution, how often they work on problems with no obvious method of solution, and how often they design their own problems to solve. On TLC's problem solving index, Co-NECT teachers score lower than any other comparison category. They even score lower than the non-participants in schools where other teachers are targeted. Meanwhile, the large disparity between those non-participants and those targeted individuals appears once again when looking at the problem solving index score. Individuals participating in these reform programs are more than one-half standard deviation above all other groups, while the others are congregated in the -.10 to +.10 range. (See Figure 33) Why do Co-NECT teachers score so low on this problem solving index, when they are usually so similar to the individual technology program participants?

The particular index components on which Co-NECT teachers fall behind other teachers are in the percentage of teachers who have students work in small groups to solve problems at least monthly and who have students solve problems with no obvious solutions at least monthly. Only 59% of Co-NECT teachers have students co-operate with one another in groups to solve problems this often while between two thirds and three quarters of other teachers have their students do so with the exception of non-participants in schools where other teachers participate in reform. (This latter group is as unlikely to have students work in groups to solve problems as Co-NECT.) Even more drastic is the difference in percentage between Co-NECT teachers assigning problems with no obvious solution to students at least monthly. Only one quarter of Co-NECT teachers do so compared to between 33% and 60% of all other groups of teachers studied. (See Figures 34 and 35)

## **CHANGES IN PEDAGOGY AND TECHNOLOGY'S ROLE**

### **Change in the Last 3 Years**

What role do computers play in changing teacher pedagogy in a constructivist direction? In order to address this question, we first examined whether or not Co-NECT teachers are reporting any change in the first place. In order to measure changes in teaching practice consistent models of reform, several survey questions asked teachers to assess whether they were engaging in various practices "much more," "more," "about the same" or "less" than three years earlier. Some practices were those reflecting constructivist ideas; others reflected more traditional ones.

Notably, we found that Co-NECT teachers reported changes in a constructivist direction on two items: having students do more long projects and having students do less work from a textbook or worksheet. In fact, 100% of Co-NECT teachers say that they have students work on long projects more often now than they did 3 years ago, and 100% of them are less likely now than 3 years ago to have students answer questions from a textbook or worksheet. Among other comparison categories, less than 60% of teachers reported that this was the case. (See Figures 36 and 37)

Although those findings suggests that Co-NECT teachers are experimenting with non-traditional teaching such as having students explore subject matter through hands-on projects rather than through the textbook, whether Co-NECT teachers are allowing students to construct knowledge on their own is still at issue.

Co-NECT teachers seem more traditional in that they are less likely than other groups of teachers to report that students now explore a topic more on their own. They are also less likely than other groups of teachers to say that their students now are making predictions and investigating them more than they had done previously in their career. Less than one quarter of Co-NECT teachers reported students exploring a topic on their own more often now than 3 years ago, a smaller percentage than any other group of teachers. In fact the majority of teachers in other categories, including the Low SES national sample, said that their students were doing more independent exploration now than before. (See Figure 38) This was also the case for having students make predictions and investigate them. Only 15% of Co-NECT teachers reported that they have students do so more now than before, compared a majority of teachers in most of the other comparison categories. (See Figure 39) Three explanations for these results seem consistent with the data. First, it may be that Co-NECT teachers were already more oriented towards individual student initiative and therefore were less likely to report recent changes in this direction. Second, it may be that Co-NECT teachers' student projects are so collaborative in nature that they simply don't see this as "students exploring a topic on their own." However, a third possibility also exists: namely, especially in the case of scientific prediction and investigation, this is simply not a direction that the Co-NECT curriculum has developed, and so Co-NECT teachers who are otherwise constructivist have not developed that aspect of their teaching practice.

Nevertheless, based on an overall index of constructivist change, Co-NECT teachers reported the most change in a constructivist direction. The index took into account how much more or less teachers incorporated 16 different aspects of teaching into their practice. For example, eight of these were: a) plan a lesson using principles of direct instruction (review, teach, guided practice, individual practice; coded "traditional change") b) have many activities going on in the room at the same time; c) use the textbook as a primary guide through units (traditional); d) let student interest partly influence the topics in the lesson, e) closely monitor and supervise students while they work (traditional); f) give students a reward for doing well on a big assignment (traditional); g) evaluate students through their products; and h) allow themselves to be taught by students. The average score of Co-NECT teachers on this index was more than one-half of a standard deviation above the next-highest group of teachers, those in high-end technology schools. This is a huge difference, particularly in comparison to the score of the other most constructivist group of teachers, the individual participants in

technology reform programs. This latter group, although scoring as constructivist in practice as the Co-NECT teachers, clearly have been constructivist for more of their teaching career than the Co-NECT teachers. The results of this figure (See Figure 40) provide the strongest evidence of the impact of the program on teachers at the Co-NECT schools.

### The Role of Computers in Instructional Change

Not only have Co-NECT teachers undergone the most constructivist change in the last three years, but along with the participants in technology-based individual reform programs, Co-NECT teachers were also those most likely to report that computers played a substantial or major role in that change (61% and 65% respectively reported that this was the case compared to only 28% of the national sample). But, even 43% of teachers in the school-wide non-technology programs report that computers play at least a substantial role in their instructional change suggesting that across the board, computers are influencing teaching practice where the climate for reform is strong. (See Figure 41)

### The Role of Computers in Changing Teachers' Own Professional Practice

The TLC survey also examined the degree to which computers change the way teachers approach their professional responsibilities as well. For example, we asked teachers how much more they collaborated with other teachers in ways such as working with other teachers on curriculum planning, spending more time preparing lessons and reflecting deeply about good teaching more now than 3 years ago. We were surprised to find that Co-NECT teachers were somewhat less likely to report increased collaboration than all the other groups. This may simply mean that they were already collaborators before. (See Figure 42) Unlike other teachers, almost all of Co-NECT teachers reported that computers played a substantial or major role in this change in professional practice (94% compared to between 25% and 45% of other teachers). (See Figure 43)

## PROFESSIONAL VS. CLASSROOM ROLE ORIENTATION

Schools' capacity to systematically improve the educational opportunities which their teachers offer to their student clientele depends on more than having sufficient computer resources available. It depends on the ability of the school as an organization to mobilize talent and expertise on behalf of the entire organization, not just towards success in individual teachers' classrooms. Different approaches to mobilizing school organizations are advocated by those with different theories of organizational change. Some approaches depend upon external pressures, such as those based on a theory of external accountability and externally judged performance. Others depend on restructuring the market for school services, such as through open-enrollment, voucher programs, or charter schools. But others depend on a theory of the professionalization of the teaching role and on the development of peer leadership among teachers. The Co-NECT school model appears to be based in a substantial way on the third of these approaches—depending to some extent on external expertise, but largely on the development of expertise and leadership that is internal to each school. This is important because, we have found in other analysis of TLC data that the more teachers interact with others within their profession and the more they take on roles as leaders of their profession,

the more likely those teachers believe in and move their teaching practice towards a constructivist pedagogy.<sup>1</sup>

The Teaching, Learning, and Computing survey studied the extent to which different groups of teachers had within themselves an orientation towards the teaching role that emphasized peer leadership as opposed to simply attention to one's own classroom teaching responsibilities. We also examined the extent to which different groups of teachers themselves had made investments in their own education—an indication of how much expertise, for example, that different groups of schools had within their teaching population.

In the TLC study, a teacher's "role orientation" was measured in terms of a) interactions with other teachers at their own school (discussion of professional matters and mutual observation of classroom teaching); b) contact with teachers at other schools (through workshops, conferences, district/area committee meetings, and e-mail); and c) leadership (mentoring, teaching peers in workshops or conferences, college teaching, and publishing articles in teacher-read journals).

In terms of interactions with teachers in their own schools, Co-NECT teachers report by far the highest levels of mutual classroom observation of any of the categories of teachers in the study. Their mean score, for example, was more than 0.8 of a standard deviation above the national teacher sample, whereas no other group exceeded 0.3. (See Figure 44) However, in terms of the frequency of having professional discussions with other teachers at their school (about curriculum issues, instructional methods, or technology), Co-NECT teachers, although slightly higher than the national sample, don't report having as many of those kinds of interactions as participants in programs targeting individuals or teachers in school-wide technology reform programs. (See Figure 45)

In terms of contact with teachers at other schools, Co-NECT teachers are more likely than any other group to participate in workshops and conferences, but they have not used e-mail to communicate with others as much as participants in individual technology-oriented reform programs. Three quarters of Co-NECT teachers (76%) interacted with teachers from other schools at workshops, classes, or conferences at least 3 times during the school year compared to less than half of the national sample. (See Figure 46) However, only 29% of Co-NECT teachers e-mailed teachers at other schools six or more times during the school year, about the same proportion as most other groups of teachers, and less than half as many of the individual technology-program participants (who were probably trained and given structural opportunities to interact with individual participants at other schools). (See Figure 47)

Participants in reform programs that target individuals score by far the highest on our leadership index which measures participation in activities such as mentoring, teaching peers in workshops or conferences, college teaching, and publishing articles in teacher read journals. Relative to the national sample, these participants average .93 standard deviations higher compared to .38 for Co-NECT teachers. Teachers at other groups of reform-oriented schools score somewhat lower, but are not far behind Co-NECT. (See Figure 48)

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<sup>1</sup> See Teacher Professionalism and the Emergence of Constructivist-Compatible Pedagogies by Henry J. Becker and Margaret M. Riel at the TLC website: [http://www.crito.uci.edu/tlc/findings/special\\_report2/start-page.htm](http://www.crito.uci.edu/tlc/findings/special_report2/start-page.htm).

Although the individual participants in other technology reform programs have greater levels of professional leadership than Co-NECT teachers, Co-NECT teachers actually have a far stronger record of investing in their own academic pursuits than those individual program participants—or any other group of teachers studied. In our research, educational investment was measured by college grade point average, highest degree attained and units taken, and most recent time a college course was taken for credit. On that basis, the mean educational investment score by Co-NECT teachers was more than one-half a standard deviation above the mean for the national sample of teachers, compared to the individual program participants' mean of .28. Co-NECT teachers were also two-thirds of a standard deviation above that of other teachers in low-SES schools. (See Figure 49) This is important because in other studies, we have shown that teachers with stronger academic backgrounds are more likely to orient themselves toward leadership within their profession. Those results also give caution; however, concerning the extent to which Co-NECT is successful because of the kinds of teachers that are recruited to (or choose to stay in) schools that follow the Co-NECT model. The extent that Co-NECT depends upon selective teacher enrollment will affect the ability of the model to successfully scale up to other, less teacher-advantaged, school sites.

## **SCHOOL CONTEXT: CULTURE, SUPPORT, PRESSURES**

### **Professional School Culture**

Role-orientation and educational investment measure individual teachers' propensity to play leadership roles in instructional reform. However, on a school-wide basis, there is the question of the extent to which teachers participate as a whole in a culture that is oriented around professionally-led instructional reform. Our measure of "Professional School Culture" attempts to assess school context as a whole by aggregating responses from the several individual teachers at each school to questions about the existence of a sense of community among teachers, whether teachers recognize each others' work and give mutual constructive criticism, whether teachers play a leadership role in staff development, and whether there is a consensus of goals exists among the educators within their school. (See Figure 50)

By an overwhelming extent, Co-NECT teachers reported the highest level of professional school culture of any of the groups studied. Their mean score was more than 1.3 standard deviations above that of the national probability sample of teachers, and nearly one full standard deviation higher than the second-best scoring group (teachers in schools with the highest technology present). Interestingly, the school culture among schools where individuals are targeted for reform score the lowest (-.36 and -.30 reported by non-participants and participants respectively). Those findings suggest that the individual reform program participants have most likely sought out reform programs out of desperation of having found little support within their immediate environments. (See Figure 51)

### **Support for Technology Use**

Our survey asked teachers about how satisfactory they felt support was for their own use of technology. Of course, satisfaction depends on both need for support and its availability and quality; for people with less need for support (either because they are experts themselves or

because they don't use technology very much), the question of quality and availability is less critical than for people who report a need for it. Support for technology was divided into three types: technical support, instructional support, and support for supervising students. Only the first two types are reported here.

In terms of technical support, fewer Co-NECT teachers than others felt the need for such support (somewhat surprising given their greater use of technology); however, of those who felt a need, a much larger percentage complained about its lack of availability than did other groups of teachers. (See Figure 52) In contrast, Co-NECT teachers are somewhat more likely than others to report a need for instructional support for using technology. This is probably because their use of technology involves a much more complex integration into curriculum objectives, rather than simply being a set of stand-alone software applications. Moreover, Co-NECT teachers also report a higher level of unmet need for this kind of support than do any other group of teachers. Overall, 50% of Co-NECT teachers report needing instructional support at least monthly and almost all of those that need this type of support find it is present at best only "frequently." In comparison, among other school-wide technology reform programs, 32% of teachers need instructional support at least monthly and more than half of those that need it report that it is available "mostly" or "almost always." The statistics are similar for teachers in high-end technology schools as for the other schoolwide technology reform programs. (See Figure 52)

### Staff Development Concerning Technology and Pedagogy

Formal opportunities to learn skills and approaches to teaching and using technology must be a part of major change efforts. The TLC survey asked teachers about the topics that were central issues in staff development programs they had participated in during the past 12 months. Co-NECT teachers reported an equal balance between issues of pedagogy (such as improving students' critical-thinking, their ability to write or to do peer review of writing) and issues of technology use (such as Internet use or creating multimedia presentations). In contrast, other schoolwide technology programs, both those that are reform-oriented and those that emphasize hardware acquisition, provide more training in technology use and less in pedagogy, while non-technology-oriented reform programs do the reverse. (See Figure 53)

### Pressures on Teachers

Pressures on teachers result from efforts to influence their teaching practice. Some level of pressure might be regarded as beneficial if it moves teachers towards a more theoretically defensible type of teaching practice. Too much pressure, however, may be counter-productive, even when it is directed towards teaching practices that might generally produce better outcomes for students.

Our study asked teachers about the extent to which they felt pressured in three directions: 1) Traditional—e.g., pressure to prepare students to take standardized tests, to cover a large quantity of curriculum content, to use a specific textbook, or teach what next year's teacher expects students to know; 2) Constructivist—e.g., pressure to do "higher order" thinking and problem solving, performance-based assessments, projects, or teach "meta-cognitive" skills;

and 3) Technology—i.e., pressure to have students use computers or have students use the Internet. Although between 70 % and 80% of all other groups of teachers felt some pressure on at least one of six items which any given teacher was asked about, that was true of 98% of Co-NECT teachers. (See Figure 54, which reports the converse, the percent of teachers reporting no pressure higher than “very little.”)

Co-NECT teachers reported, on average, higher pressures of a traditionalist sort as well as higher pressures of a constructivist sort than did the national sample. That was also true of two other groups of teachers: teachers from the national sample who teach in low-SES schools (who indeed reported pressure levels higher than Co-NECT teachers both in terms of traditional and constructivist pressures), as well as participants in individual technology-oriented reform programs. (See Figures 55 and 56) However, Co-NECT teachers were the only ones to report higher than average pressures on all three types—and they were especially adamant about the third type of pressure—pressure to use technology in their teaching, with a mean score, relative to the national sample, of +0.7 standard deviations. They felt technology-use pressures substantially more, for example, than did teachers at high-end technology schools or at schools involved in other schoolwide technology-oriented reform programs. Interestingly, participants in technology reform programs that target individuals felt the least pressure to use technology—even less than the national sample, suggesting that for such teachers, the opportunity to use technology in their teaching was something they were seeking out, rather than something that was being pushed upon them. (See Figure 57)

## SUMMARY

This examination of 21 teachers in 6 of the early-adopting Co-NECT schools has provided suggestive evidence about areas in which the Co-NECT schools program has made substantial accomplishments, relative to other types of reform programs and relative to nationally comparable schools, and areas in which accomplishments have been somewhat slower than program designers may have hoped for. Overall, though, the pattern of comparisons revealed in these data suggest a remarkable degree of implementation of technology-based instructional reform. Although this is the first analysis we have done to date of any particular reform program within the TLC database, the average scores of Co-NECT teachers on measures of pedagogy, technology use, professional role-orientation, and school professional culture, taken as a whole, could well turn out to be higher overall than any other program effort sufficiently present in the database for comparative data to be produced.

Co-NECT teachers have more computer technology present in their classrooms than any of the seven other groups of teachers with which they have been compared. Their use of computer software with students is comparable in extent and sophistication with that of individual teachers who participate in technology-oriented reform programs which target individual teachers rather than whole schools. Co-NECT teachers’ use of software is substantially greater than any other schoolwide comparison group including high-end technology schools and other schools engaging in schoolwide technology reform.

Particularly in comparison to teachers in other low-income schools, Co-NECT teachers have objectives for computer use that are constructivist in their intent and look much more like the

patterns of computer use found in more advantaged community environments. The only area of student computer use in which there is a clear weakness in Co-NECT schools is in the area of higher-order uses of computers, such as for analyzing information and ideas. However, on another measure, the extent that students are reported to be doing work for their classes at school but on their own time, Co-NECT teachers report the greatest level of student involvement. This suggests that a principal benefit to effective technology programs—students expanding the amount of time they engage in serious productive work—is being accomplished at Co-NECT schools more than elsewhere.

A large proportion of Co-NECT teachers have had computers themselves for many years, and this translates into substantial levels of computer expertise. However, their professional use of computers is targeted to specialized applications, which results in a more modest measure of overall professional use of computers than might be predicted. Co-NECT teachers also report needing more support for instructional applications of computers than do other teachers, and if a teacher feels that, she is very likely to report that it is insufficiently available. Finally, Co-NECT teachers feel substantial amounts of pressure to use computers in their teaching, which, when combined with above-average pressures to reach traditional teaching objectives and even constructivist ones, seems to result in an overly high-pressured atmosphere that may limit how much teachers can accomplish.

Consistent with their reports of how they use computers, Co-NECT teachers are pedagogically constructivist in terms of their teaching philosophies, their use of projects, student-led activities, and other elements of a meaning-oriented instructional practice, as well as in areas of higher cognitive challenge such as reflective writing and some measures of divergent thinking. However, they are not distinct in terms of giving students tasks calling for open-ended problem-solving and giving students independent responsibility for designing and organizing problem-solving efforts, such as making and investigating their own predictions. However, many of the difficulties of implementing a higher-order approach to curriculum and instruction are experienced to the same degree by other teachers serving low-income student populations.

The surveyed Co-NECT teachers report having made substantial changes during the previous three years towards practicing a more constructivist pedagogy, but mainly in terms of practices that make learning more meaningful rather than in areas of critical inquiry. Overall, Co-NECT teachers report by far the greatest extent of recent change towards a constructivist-compatible teaching practice of any groups being compared, and a majority of Co-NECT teachers attribute a major role in those changes to their use of computers.

Co-NECT teachers also show themselves to be life-long learners who have made great investments in their own education and generally exhibit a professional role orientation, including peer leadership activities. Most profoundly, at a school level these six Co-NECT schools exhibit a strong professional culture, by far stronger than any other comparison group of schools. This suggests that the program is laying a strong foundation for sustaining schoolwide professional change over the long term.

Although this examination of a small sample of participating Co-NECT teachers cannot provide as reliable a portrait of the progress of the Co-NECT program as a larger, more

focused evaluation study could do, these findings are basically consistent with what we understand to be the context and efforts of the Co-NECT program. We hope that the relatively broad-ranging nature of this examination, despite its small case base, will be useful in fostering a greater understanding of the progress being made by schools implementing this technology-rich, constructivist-oriented schoolwide design program.

## APPENDIX A – TLC SAMPLING PROCEDURE AND RESPONSE RATE

This Appendix provides additional details about the TLC sample than provided in the introductory section of this report.

Somewhat more than one-half of the 1,616 schools sampled for the study (56%) were a stratified national probability sample of elementary (299 schools), middle (253), and high schools (346), including 83 private and parochial schools. Those schools were sampled with probabilities related to both size (estimated number of full-time teachers, grades 4 to 12) and the presence of computer technology (based on an index developed for Quality Education Data, Inc.). The sampling universe was the approximately 108,000 schools in the Quality Education Data (QED) database.

The remaining samples of schools are referred to as “purposive samples” and were based on compiling, refining, and sampling from lists of two basic types of schools: “High-End Technology Schools” are schools with substantial amounts of computer technology per capita, including schools selected from the QED technology presence index and schools identified through books, articles in magazines and school web-sites. “Reform Program schools” were compiled by identifying schools or individual teachers who had been long-term (2 year+) participants in one of 54 different national or regional externally-defined “programs” of major school or instructional reform.

In all three school samples, teachers were sampled from grades 4-12 and from all subjects except physical education and special education. At each sampled school, three to five teachers (3, elementary; 5, middle and high school) were selected with probabilities related to the teacher’s reputed instructional practices and use of technology. A small number of teachers (a maximum of 2 per school) were selected with certainty (probability equal to 1) based on the principal’s attribution of that teacher having an exemplary instructional practice or based on their known participation in the selected program of instructional reform. Because unequal probabilities were used, at both school and teacher level, all analysis employs weighted data with weights inverse to the probability of selection, as modified by stratum-specific non-response rates and within-school partial completions of teacher rosters.

### Participating Schools

Across the three samples, 1,215 of the 1,616 schools selected for participation agreed to participate in the study (75%). The attained probability sample or “national” sample (rostered schools) consists of 598 public and 57 private and parochial schools. The High-end Technology sample includes 182 rostered schools including 86 entering the sample based on having among the highest technology presence index scores in the QED database. The remainder were believed to have substantial computer and Internet technology, as identified through publicly available information from school Web sites, books, and magazine articles. Finally, the Reform Program sample includes 378 rostered schools that were identified through various sources as being involved in one of 53 different reform efforts.

The “reform program” and “high-end technology” samples involve some definitional overlap in that 13 of the reform programs (with 90 rostered schools) appear to have substantial amounts of technology, while 72 rostered high-end technology schools appear to have explicit instructional reform emphases even though they did not participate in any of the major reform programs selected. A majority of Reform Program schools are involved in a school-wide reform program (e.g., Coalition of Essential Schools, League of Professional Schools, Bay Area School Reform Collaborative, Co-NECT Schools) These total 30 separate programs (200 schools) including four with a technology emphasis and five that are not ‘programs’ per se but schools linked by a common origin (e.g., ‘Charter Schools with a constructivist flavor’). In addition, there are four programs that are limited to math and/or science (26 schools), 17 programs that enrolled individual teacher participants (nine of these are technology-centered), and two programs that recognized individual exemplary teachers.

### Selection of Teachers

At each of the 1,616 studied schools, samples of 3 (elementary) or 5 (middle and high school) teachers were drawn through probability sampling methods. Principals of the participating schools were asked to roster either 10 (elementary) or 15 (secondary) teachers of grade 4 or higher (in some cases limited to the same subject taught by a reform program-participating teacher), starting with teachers with last names beginning with a randomly selected letter of the alphabet and proceeding alphabetically. The roster form asked for 4 additional pieces of information about the rostered teachers that were used to assign sampling weights to each rostered teacher (e.g., subject taught, use of computers, use of projects in teaching).

In addition, two other sources of teachers were incorporated as purposive samples. Approximately 250 teachers were individually selected from the purposive school samples based on reports (public or program-supplied) of their participation in educational reform activities. And finally, approximately 800 teachers were chosen through nominations by principals (as part of the Roster form) as exemplary practitioners of constructivist approaches to teaching.

### Attained Sample

Response rates of individually selected teachers, principals, and technology coordinators averaged about 70%. Altogether, responses were obtained from 4,083 teachers of grade 4 and higher in 1,150 schools, as well as 845 technology coordinators and 867 school principals.