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ABSTRACT

This report, the forth in a series from the spring 1998 national survey, "Teaching, Learning, and Computing," examines teachers' survey responses that describe the frequency with which their teaching practice involves those five types of activities and the frequency with which their practice involves more traditional transmission and skill-development activities instead. Behind all teaching practices and beliefs about teaching are two overarching approaches to teaching that represent different and somewhat incompatible models of good pedagogy: traditional transmission instruction and constructivist-compatible instruction. A constructivist learning environment tends to involve these five types of activities: projects, group work, problem-solving tasks, reflective thought through writing, and a variety of other tasks that engage students in meaningful thinking. In addition, the report examines specific teacher beliefs reflecting a teaching philosophy consistent with the use of those activities, and beliefs reflecting a teaching philosophy that runs counter to these teaching practices. Data are presented in 43 tables throughout the report. Supplementary tables and a summary of study methodology are appended. Contains 23 references. (Author/AEF)

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INTRODUCTION

PERSPECTIVES ON TEACHING AND LEARNING

No two teachers are perfectly alike in how they practice their craft and in their beliefs about teaching and learning that underlie those practices. Most teachers are eclectic, choosing from a large repertoire of teaching strategies as the particular situation warrants. However, behind all of these specific teaching practices and beliefs about teaching are two overarching approaches to teaching that represent different and somewhat incompatible models of good pedagogy:

- Traditional Transmission Instruction is based on a theory of learning that suggests that students will learn facts, concepts, and understandings by absorbing the content of their teacher's explanations or by reading explanations from a text and answering related questions. Skills (procedural knowledge) are mastered through guided and repetitive practice of each skill in sequence, in a systematic and highly prescribed fashion, and done largely independent of complex applications in which those skills might play some role.

- Constructivist-Compatible Instruction is based on a theory of learning that suggests that understanding arises only through prolonged engagement of the learner in relating new ideas and explanations to the learner's own prior beliefs. A corollary of that assertion is that the capacity to employ procedural knowledge (skills) comes only from experience in working with concrete problems that provide experience in deciding how and when to call upon each of a diverse set of skills.

The contrast between these two models has a long history in education, going back to debates about progressive education. However, current interest in constructivist-compatible instruction can be traced to the public and professional dialogues over alternative approaches to school reform that followed the publication of the *Nation at Risk* report (National Commission on Excellence in Education, 1983)—for example, the U.S. Department of Labor's proposal for emphasizing work-relevant competencies (Secretary's Commission on Achieving Necessary Skills, 1991). During the 1990's, various education reform efforts have proposed many different changes in school curricula, teachers' instructional strategies, and organizational arrangements (Hill and Celio, 1998). Many of these efforts have a strong constructivist flavor, with classroom activities, curricular content, and school organization all designed to be more consistent with a constructivist understanding of the learning process than are traditional practices and programs. (See, for example Lamon, et. al., 1996; Stringfield, Ross, and Smith, 1998).

There are several basic aspects to the transmission-vs.-constructivist contrast. The basic difference, already introduced, is in terms of the theory of student learning that undergirds instructional practice—i.e., the difference between learning through reception of facts and repetitive practice of discrete skills versus learning through effortful integration of new ideas with those previously believed.

A second critical element distinguishing transmission-based and constructivist-compatible instruction deals with the role of teacher and student. In a transmission-oriented learning theory, a teacher's job consists of planning a set of activities in which particular subject content is experienced by students (e.g., teacher presentation of new information, students answering questions in textbook). Procedures for independent student work are defined in detail so that their work can efficiently be accomplished with as few errors and as little confusion as possible. In contrast, a constructivist learning theory maintains that because learning is a constructive process, mistakes and confusion sometimes provide the engagement that is needed for effortful learning. In constructivist teaching, the natural starting point for instruction is not the material to be taught, but student interests, prior experiences, and current understandings. Because not

all students begin at the same point, and have different questions they seek to answer, the content and activities of student work will vary within a classroom from student to student. The teacher's role, in this approach, is to facilitate student-designed efforts. This is a more demanding job than merely studying and then presenting to students a pre-ordained body of content. Because constructivist approaches involve greater variety in the objects of learning across different students, and because they grant greater authority to students to decide upon the content of their learning, teachers implementing a constructivist-compatible pedagogy must have a wider range of knowledge and skills from which to draw.

A third difference between these two pedagogical approaches is the importance that constructivism assigns to systematically created social structures for learning. Debates between students, cooperative group projects, and other activities involving the articulation of students' own ideas in concrete contexts are valued by constructivists for their power to further individual understanding. A transmission-oriented philosophy does not emphasize the social mediation of ideas because it sees understanding as coming from listening and reading—from receiving explanations directly—rather than as a result of actively working with and applying those ideas in a social context.

In summary, a constructivist teaching approach attempts to make learning a more self-directed, personally-responsive, and socially-mediated process in which a learner's own motivation and effort are just as important, if not more central, to a student's education than the content or facts learned. This involves creating a learning environment so that students:

- Identify their own issues and problems to be solved rather than having questions defined for them
- Decide *how* to explore an issue or solve a problem rather than having these procedures defined by the teacher
- Reflect further and makes sense of what they have experienced, and
- Interact with peers by presenting their solutions, describing how solutions were reached, and receiving feedback.

A classroom where these principles—rather than transmission- or skills-practice principles—guide a majority of moment-to-moment teaching decisions would be considered a "constructivist learning environment." A constructivist learning environment tends to involve activities of the following five types:

- Projects in which students employ a variety of skills and engage in a diverse set of tasks to accomplish a goal that, even if only implicitly, involves developing their understanding of important content.

- Group work—where student tasks involve interdependencies with other students and, in particular, where discourse with other students is facilitated.

- Problem-solving tasks: in other words, where the procedural knowledge present for solving a problem is not algorithmic but requires thinking, evaluating, decision-making, and planning as well; and where the definition of the problems themselves may be the responsibility of the student.

- Reflective thought through writing. Exposition of a reasoned argument in written form is perhaps the most powerful and most general medium for engaging people with ideas—and with their development of understanding.

- A variety of other tasks, in addition to reflective writing, that engage students in meaningful thinking—engaging them in a way that they consider both new information and their own prior understandings and beliefs and attempt to work out syntheses of both the old and the new. Those tasks

include, for example, having students make conjectures, eliciting their opinions, having them explicitly work on issues related to their own experiences, and arguing for various points of view.

This report examines teachers' survey responses that describe the frequency with which their teaching practice involves those five types of activities and the frequency with which their practice involves more traditional transmission and skill-development activities instead. In addition, the report examines specific teacher beliefs reflecting a teaching philosophy consistent with the use of these activities, and beliefs reflecting a teaching philosophy that runs counter to these teaching practices.

THE STUDY OF TEACHER BELIEFS AND PRACTICES THROUGH SURVEY METHODS

The policy community has not really reached a consensus about whether most teachers' beliefs about good teaching as well as their actual frequency of employing different teaching practices is closer to a transmission theory or to a constructivist one. Some scholars (e.g., Cuban, 1993) argue that, influenced by strong cultural norms that support a conventional model of teaching and learning and by highly constraining work environments, most teachers hold beliefs consistent with a transmission pedagogy and only rarely engage their classes in constructivist-compatible activities. Others (e.g., Hirsch, 1996) argue that, influenced by colleges of teacher education where Deweyian world-views have predominated for many decades, most teachers, particularly elementary teachers, have a constructivist philosophy and (unfortunately, from Hirsch's viewpoint) implement that philosophy in their practice. Still others (Becker and Riel, 1999) argue that teachers' philosophies are largely constructivist but that the school bureaucratic culture and public expectations for measurable documentation of student "achievement" severely constrain most teachers from implementing a constructivist pedagogy in daily practice. In sum, a variety of claims are made about the current distribution of teachers' beliefs about good teaching and the frequency of specific teaching practices that are associated with those contrasting beliefs—both among all teachers and among different groups of teachers.

Several recent national studies of teaching practice—e.g., the 1993 National Survey of Science and Mathematics education (Weiss et al, 1994), NCES' 1994-95 Teacher Follow-up Survey (Henke, et al, 1999), and the TIMSS international study (Schmidt, W. H. et al, 1997)—measured various aspects of teacher pedagogy. However, some analysts regard findings presented in reports of those studies with some degree of suspicion, in that only the TIMSS study was accompanied by studies of teacher practices by more in-depth observational methods (Schmidt, et al, 1996; and Stevenson, H. W. & Stigler, J. W., 1992), and none of the studies conducted any measurements of the validity of survey reports about teacher practices.

Validity of Survey Measures of Teacher Beliefs and Practices

Many researchers who observe teachers in day-to-day practice are quite suspicious of survey methodology for accurately measuring teacher beliefs or practices. To a large extent, survey questions can only get at the surface of teacher behavior whereas it seems plausible that important distinctions between effective and ineffective practices lie in the particular ways that teachers implement any particular "practice" such as "having students take greater responsibility in devising solutions to problems." Discourse practices, in particular, seem likely to be difficult to measure through survey approaches. Secondly, many people suspect that "social desirability" (i.e., survey respondents' beliefs about how different responses would be evaluated by significant others) bias survey responses to questions about their beliefs and instructional practices.

The most well-known study of the validity of survey measures of teachers' behavioral self-reports is Burstein, *et al*'s (1995) study of teachers' curricula and instructional practices. Their study was based on 70 mathematics teachers from nine schools in two states, but rather than using actual classroom

observations as validity criteria, the study used daily teacher logs and copies of teacher-made tests and homework assignments instead. Burstein, *et al* found that absolute agreement on most dimensions of mathematics teaching practice (e.g., how frequently teachers had students do such things as work with manipulatives, work individually on written assignments, or work in small groups) was generally in the 40% to 60% range, using 4-point scales. As Mayer (1999) argues, that level of agreement is not impressive, given there were only four response points to the survey items.

The Burstein study, though, looked at validity in only one of several possible ways. Two dimensions of validity measurement need to be considered: (1) "absolute" agreement versus "relative validity," the relative ordering among respondents; and (2) the validity of individual survey items versus that of an index or compilation of items.

Absolute agreement is the similarity between survey reports and criterion measures—for example, how frequently teachers used manipulatives to demonstrate a concept. Relative validity is the correlation across teachers in their relative placement along each of two measures, a survey measure and a criterion (e.g., observational) measure. Absolute agreement, the focus of the Burstein study, is required for accurate descriptions of teaching practice across a population of teachers. However, similar *relative* placements are all that is required in an analytic study to confirm that variations in teacher pedagogy are associated with variations in other aspects of teaching—for example, subject taught or the teacher's use of computers.

The second distinction is between the validity of individual survey questions and the validity of indices built by scaling or factor analyzing a number of indicators of a common underlying dimension. The Burstein study was concerned with the validity of individual survey indicators rather than indices. Yet, as psychology students are taught from their first class in statistics, single dichotomies, or even 4- or 5-point response items, inevitably suffer from limited precision, and in fact represent only indicators of more general constructs, which are inherently of greater interest.

An earlier study, by Smithson and Porter (1994), provided correlational validity measurements for individual survey items, such as teachers' use of lab work, small group work, and recitation activities. Generally, Smithson and Porter found correlations between frequencies as reported on teacher surveys and frequency of entries in teacher logs in the 0.4 to 0.6 range for nearly all of the (fairly general) instructional practices they examined. Mayer himself conducted another study (Mayer, 1999), albeit a small one, of nine Algebra teachers in one district, where actual classroom observations were employed as the criterion measure. He found that, despite very low over-time (4-month) reliability measures of 17 individual pedagogical practices (e.g., make conjectures, engage in student-led discussion, work from a textbook, take computational tests), an index-level survey measure was highly correlated (+0.85) with a corresponding measure based on substantial classroom observations (three periods spaced over three weeks). The index was based on the relative frequency of 13 reform practices compared to the frequency of 4 traditional practices. Thus, although absolute individual-level findings may suffer from unreliability and bias compared to more in-depth measurements, relative validities may be quite satisfactory for many purposes (i.e., differences between contrasting teacher populations), and index-level correlational analysis may have very high validity.

Preliminary Validity Study

Not every survey measure of teacher belief or teaching practice may be equally valid or reliable. The Smithson-Porter study found correlations as low as 0.21 ("write a report or paper") and as high as 0.65 ("do lab or field work"). In preparation for our national survey, Computer Technology and Instructional Reform, which is the source of the data on teacher beliefs and practices in this report, we conducted a validity study in order to select survey items that were most highly correlated with observation and interview-based criteria of similar dimensions of belief and practice.

The validity study was conducted with 72 teachers from 24 schools in three parts of the country. In contrast to Mayer's study, our teachers were heterogeneous in subject responsibilities and school level. Like Mayer, we correlated teacher survey responses with coded observation data. However, we also interviewed respondents at length (roughly 2 hours per teacher), examined written assignments, quizzes, and other available artifacts, and had interviewer-observers complete the same survey instrument as the teacher respondents as if they were an "objective observer" of that respondent's practices and teaching philosophy. In addition to survey items asking the teacher to generalize about her use or frequency of use of different teaching practices—for example, "When you ask students questions, how frequently are you doing so in order to... get students to explain their reasoning?"—the validation survey asked questions about teaching philosophy as well—for example, agreement or disagreement with the suggestion that students must acquire basic skills before they are ready for "meaningful" learning.[1]

In general, we found that although most single-item survey measures correlated only in the 0.20 to 0.40 range with single-item criterion measures (Becker and Anderson, 1998), when we combined several of the better-correlating and substantively related survey items into an index and correlated the index with more complex validation criteria (factor scores based on multiple sources of evidence), the relationships were substantially stronger. For the 24 aspects of constructivist philosophy and practice having at least three survey items that had correlated at least 0.30 with the objective-observer scoring of that item, the median index-to-factor correlation was 0.51.[2] When we built three second-level indices out of more comprehensive sets of survey items (representing the three primary dimensions of constructivism in our thinking at the time—meaningful learning tasks, cognitively demanding tasks, and social learning), the correlations with similarly defined factor scores were, respectively, 0.60, 0.62, and 0.68 (Becker, 2000b).[3]

Overall, the use of indices and focusing on a "relative" rather than "absolute" perspective on validity made us quite confident that self-report measures of pedagogy and philosophy would be sufficiently valid for the primary analytic purposes of our national survey.

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[1] "Validation" in our preliminary study meant three things: (1) the correlation of survey items with the parallel "objective observer" item scored by the research team member; (2) the correlation of individual survey items with "validation factor scores" built by combining a set of coded responses made by the research team members from a variety of evidence (interviews, observations, coding of artifacts, and the "objective observer" report); and (3) the correlation of an index combining substantively related teacher survey responses with the validation factor scores described above. The indices and validation factor scores represented efforts to operationalize theoretically derived components and sub-components of the overall construct of constructivist-compatible pedagogy. Items measuring substantively similar beliefs and practices were combined in the analysis because exploratory factor analysis found no way to consistently distinguish them based on factor loadings. (In the current study, our factor analyses did consistently distinguish between belief and practice survey items. See Becker and Anderson (1998) and Becker (2000b) for more details about the validation study.

[2] The median number of items in an index was 5. The range was from 3 to 10 items per index.

[3] There were 20 survey items measuring meaningful tasks, 23 measuring cognitively demanding tasks, and 19 measuring social learning.

For the national survey, we selected items based on their validity but also in order to accomplish a broad domain coverage of the constructivist-transmission-orientation distinction. In addition, we modified items and restructured some in order to optimize domain coverage in minimum space and with attention to the particular items that correlated the best with our criterion measure. (For example, we combined pairs of items that had presented contrasting perspectives into several paired comparisons.) For the items drawn from the validity study that were used in the national study, an index of the 21 items measuring meaningful learning tasks correlated 0.54 with the factor score for that component of the validation items (i.e., interview, observation, and other items measuring the same aspects of the construct); the index of the 26 items measuring cognitively demanding tasks correlated 0.70 with its validation factor score, and the index of 11 items measuring social learning correlated 0.67 with its factor score. The lower correlation for the meaningful-tasks component of constructivist pedagogy appears to be due to the greater heterogeneity of that construct.

THE TEACHING, LEARNING, AND COMPUTING 1998 NATIONAL SURVEY

Our data on teachers' beliefs about teaching and learning and their teaching practices comes from a national survey, conducted during the Spring of 1998, that focused on the relationship between teacher pedagogy and their use of computers in teaching. The study was funded by the National Science Foundation with additional funds provided by the Office of Educational Research and Improvement, U.S. Department of Education. Called Teaching, Learning, and Computing—1998 (TLC), the survey involved questionnaire responses from three different samples of schools—a national probability sample, a purposively drawn sample of schools with the greatest per-capita computer technology, and a purposively drawn sample of schools that were participating in some way in substantial educational reform efforts, either self-initiated or as part of one of 50 different national or regional reform programs. Within each school, the TLC survey collected data from the principal, the school technology coordinator, and a probability sample of teachers. The teachers were selected in a way that disproportionately oversampled those who made substantial use of computers, who had students do project work, and who emphasized higher-order thinking in their teaching. However, all analyses use weights that compensate for differential sampling rates of different types of teachers so that the results can be seen as coming from a representative sample of teachers at the schools surveyed. For the most part, the information in this report comes from the national probability sample of schools; however, the more analytic work incorporates the purposive samples as well, and when that is done it is noted in the text or accompanying table.

The teachers whose responses are described in this report number 4,083, including 2,251 in the national probability sample of schools. The teachers are those who taught classrooms from the 4th through the 12th grades in all subjects except physical education and special education. The teachers completed 20-page survey instruments. Some survey questions were asked to subsets of respondents (four different overlapping questionnaire versions were used), so some of the data was not based on the full sample surveyed. The teacher respondents represent 69% of the teachers sampled; and the schools participating include 75% of the schools initially selected. Additional information regarding the methodology of the study is provided in Appendix B.

PART I. TEACHERS' BELIEFS ABOUT TEACHING AND LEARNING

To understand teachers' pedagogy, it is important to understand their beliefs about what constitutes good instructional practice. Presumably, their own instructional practices reflect, to a large extent, what they believe to be good teaching, and their beliefs about good teaching reflect their understandings about how students learn. Of course, many other factors affect teachers' individual practices besides their philosophies of teaching—for example, class sizes that are larger or more heterogeneous than they expected, the content of the specific textbook provided to them, resources which they expected but which were not provided, explicit directives from administrators, influences of their peers, etc. An important element in this project's investigation into teachers' use of computers is to inquire whether teachers who use computers frequently with students have become more constructivist in practice than their own teaching philosophy would suggest that they would be (and to study under what circumstances, those effects take place). To do that, we must know to what extent teaching philosophy does predict instructional practice, and preparatory to doing *that*, we examine the character and distribution of specific beliefs that make up those teaching philosophies.

DESCRIPTIVE FINDINGS

Teachers' beliefs about good teaching, and more implicitly, their beliefs about the nature of learning, were measured mainly through three questions in the TLC survey: one question which presented a paragraph-length vignette describing how two hypothetical teachers—Ms. Hill and Mr. Jones—characteristically taught their class; a second question in which several pairs of contrasting statements of teaching philosophy were presented, asking respondents to choose on a 5-point scale which statement among the pair came closest to their own point of view; and a set of general statements about teaching and learning, presenting respondents with 6 alternatives from "strongly disagree" to "strongly agree." The full range of responses by teachers in the national probability sample to each of the items in these three questions, as well as to the questions measuring actual teacher classroom practices, is provided in Appendix C.

The "Ms. Hill vs. Mr. Jones" vignettes were used to gauge teachers' overall preference for, and beliefs about, contrasting direct instruction and constructivist instructional styles. (See Figure 1 for the vignettes used.) Although most teachers can see value and a reason to teach like either teacher, in different situations, a preference for Mr. Jones' pedagogy suggests a clearer belief in the value of constructivist instructional reforms. Respondents were asked to evaluate the two alternative teaching styles with respect to four criteria: with which approach were they more comfortable, which approach did they think students preferred, from which approach did they think students gained more knowledge, and from which approach did they think students gained more useful skills.

FIGURE 1: VIGNETTES DESCRIBING CONTRASTING INSTRUCTIONAL STYLES

Ms. Hill was leading her class in an animated way, asking questions that the students could answer quickly; based on the reading they 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' class was also having a discussion, but many of the questions came from the students themselves. 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.

Overall, more teachers *felt comfortable with* (64%) and thought *students preferred* (53%) the traditional style of Ms. Hill, with fewer selecting Mr. Jones. (The middle or "undecided" position was chosen by many teachers as well; see Table 1.) Moving quickly over content may pose fewer problems for teachers and students and therefore seem easier. However, in terms of the *consequences* for students, teachers were

more likely to believe that Mr. Jones' approach was better. Concerning students gaining more *knowledge* from Hill or Jones, teachers were evenly split — with more than 40% favoring each approach. Concerning the acquisition of *useful skills* many more teachers favored Mr. Jones' approach (57% favoring Jones, 29% favoring Hill). This suggests that teachers think students will benefit from some use of inquiry-oriented teaching that places more responsibility on students. At the same time, they recognize that it is difficult to carry out many of those practices, particularly because not all students are eager to participate in classroom learning organized around those practices.

TABLE 1: TEACHERS' BELIEFS ABOUT CONTRASTING INSTRUCTIONAL STYLES

	Favored Ms. Hill (traditional approach)	Middle position on 5-point scale	Favored Mr. Jones (constructivist approach)
They would be more comfortable	64%	7%	28%
They think students prefer	53%	10%	37%
Students gain more knowledge	44%	14%	42%
Students gain more useful skills	29%	14%	57%

Sample: Probability sample, questionnaire versions 3 and 4.

In the paired comparison question, five pairs of philosophical positions were presented, four of which we discuss here. One expressed the contrast in the role of the teacher between being a facilitator of student learning versus an explainer of material to students, very much encapsulating the difference in approach between Ms. Hill and Mr. Jones in the earlier question. A second pair contrasted a teaching approach where multiple activities were going on in class at the same time, activities suggestive of complex project work and a fair amount of latitude for students, versus a classroom where everyone was working on the same assignment, one with "clear directions, and...that can be done in short intervals that match students' attention spans and the daily class schedule." A third comparison was between the position that curriculum content coverage was more important than "encouraging sense making" among students versus the opposite position, and the fourth was whether promoting student interest or learning content skills was more important. (See Figure 2.)

FIGURE 2: PAIRED COMPARISONS MEASURING CONTRASTING TEACHER BELIEFS

Constructivist Perspective		Traditional Transmission Perspective
"I mainly see my role as a facilitator. I try to provide opportunities and resources for my students to discover or construct concepts for themselves."	Vs.	"That's all nice, but students really won't learn the subject unless you go over the material in a structured way. It's my job to explain, to show students how to do the work, and to assign specific practice."
"It is a good idea to have all sorts of activities going on in the classroom. Some students might produce a scene from a play they read. Others might create a miniature version of the set. It's hard to get the logistics right, but the successes are so much more important than the failures."	Vs.	"It's more practical to give the whole class the same assignment, one that has clear directions, and one that can be done in short intervals that match students' attention spans and the daily class schedule."
"The most important part of instruction is that it encourage "sense-making" or thinking among students. Content is secondary."	Vs.	"The most important part of instruction is the content of the curriculum. That content is the community's judgment about what children need to be able to know and do."
"It is critical for students to become interested in doing academic work—interest and effort are more important than the particular subject-matter they are working on."	Vs.	"While student motivation is certainly useful, it should not drive what students study. It is more important that students learn the history, science, math and language skills in their textbooks."

Overall, teachers are substantially more constructivist than traditional in their responses to each of these items. Twice as many teachers agreed that there should be multiple project-oriented activities going on as favored short-duration whole-class assignments instead. Even more teachers believed that their

instructional planning should focus on constructing meaning and on student interest than on coverage of curriculum and textbook content (by margins of 2.5 to 1 and 3 to 1 respectively; see Table 2). The facilitator-explainer contrast received a much more balanced reaction, reflecting the ambivalence teachers reported regarding these contrasting approaches in their responses about Ms. Hill and Mr. Jones from the prior question.

TABLE 2: TEACHERS' AGREEMENT WITH CONTRASTING STATEMENTS OF TEACHING PHILOSOPHY

	Favored the More Constructivist Statement	Middle position on 5-point scale	Favored the More Traditional Position
Facilitator vs. Explainer	40%	30%	30%
Multiple project activities vs. short-term whole-class assignments	48%	26%	26%
Sense-making vs. Curriculum coverage	49%	31%	19%
Student interest vs. Textbook content	55%	27%	18%

Sample: All teachers in probability sample.

These findings suggest that given a brief argument made between support for a philosophical position consistent with constructivist instructional reform and one reflecting a more traditional viewpoint, many more teachers will select agreement with reform than with traditional teaching practice.

Even when presented with statements solely supporting traditional teaching practice (without a paired argument favoring the opposite position), a majority of teachers typically will reject the practice. This is seen by the teachers' responses to the third survey question probing their beliefs about good teaching practice. Eight of ten "agree-disagree" questions posed statements consistent with traditional teaching philosophy (shown in Table 3). Of the eight, a majority of teachers disagreed with five of them and almost a majority (48 to 49%) disagreed with two others. A huge majority of teachers (85%) rejected the idea that because teachers know more than students, they "shouldn't let students muddle around when they can just explain the answers directly." Even more teachers (91%) rejected the idea that student projects aren't useful because they "often result in students learning all sorts of wrong 'knowledge.'" More than three-fifths of the teachers (62%) rejected the idea that "instruction should be built around problems with clear, correct answers, and around ideas that most students can grasp quickly"—a clear statement of rejection of the principles of direct instruction formulated two decades ago and around which most traditional instruction is based. (See Table 3.) In contrast, none of the statements reflecting traditional educational philosophy received anywhere near the level of endorsement as did one of the two statements in this survey question that reflected a constructivist philosophy: that "students should help establish criteria on which their work will be assessed." More than two-thirds of responding teachers endorsed that principle (71%), but the maximum agreement for any of the eight "traditional" statements was only 58%—a statement about homework being a good setting for answering questions in the textbook.

TABLE 3: PERCENT OF AGREEMENT AND DISAGREEMENT WITH OPINION STATEMENTS ABOUT PEDAGOGY

	Percent Agreeing	Percent Disagreeing
Traditional Pedagogy		
Student projects often result in students learning all sorts of wrong "knowledge"	9	91
Teachers know a lot more than students; they shouldn't let students muddle around when they can just explain the answers directly	16	84
Instruction should be built around problems with clear, correct answers, and around ideas that most students can grasp quickly	38	62
A quiet classroom is generally needed for effective learning	41	59
Students are not ready for "meaningful" learning until they have acquired basic reading and math skills	46	54
How much students learn depends on how much background knowledge they have—that is why teaching facts is so necessary	51	49
It is better when the teacher —not the students—decides what activities are to be done	53	47
Homework is a good setting for having students answer questions posed in their textbooks	58	42
Constructivist Pedagogy		
Students should help establish criteria on which their work will be assessed	71	29
Students will take more initiative to learn when they feel free to move around the room during class	52	48

Note: Each statement had three levels of agreement and three levels of disagreement, which are combined for this summary.
Sample: Probability sample. Each statement except the two constructivist ones was asked of only three-quarters of the teachers, balanced among the four questionnaires.

Regardless of whether these statements of teaching philosophy carry over to teachers' actual teaching practice, their endorsement of ideas about good teaching consistent with constructivist instructional reform and their equally strong rejection of traditional ideas about teaching suggest one of two things: Either teachers believe that cultural norms are suddenly supporting reform practices (and that they felt they should endorse those norms) or these beliefs are actually ones that the teachers hold. Although we do not discount the possibility that social desirability plays some role in the distribution of survey responses (and that includes the possibility that respondents perceived researcher opinion to favor constructivist statements which social desirability led them to endorse), still the consistent choices of teachers throughout these three survey questions favoring constructivist philosophies cannot be that easily dismissed. Our conclusions: as a whole, U.S. 4th through 12th grade teachers believe in a much more constructivist basis for teaching than they are often given credit for.

LEVEL AND SUBJECT-MATTER DIFFERENCES IN TEACHING PHILOSOPHY

There are certainly many reasons why some teachers hold philosophies of teaching more compatible with constructivist theories of learning than other teachers do. Their differing personal and educational backgrounds, different prior experiences in teaching, and different current teaching responsibilities all play a role. In this report, we will explore some of the clear differences in teaching philosophy between teachers teaching at different school levels and having different subject-matter responsibilities.

Elementary Teachers, Particularly Those Who Teach Self-Contained Classes, Have More Constructivist Teaching Philosophies

When we compare upper elementary teachers (i.e., those who teach grades 4 to 6 in elementary schools) to teachers at the middle school and high school level, it is clear that elementary teachers are more often constructivist in their philosophies, and they agree with "traditional" views of good teaching less often

than secondary teachers do. For example, when asked whether students are ready for "meaningful" learning before they have acquired basic reading and math skills, most secondary teachers (51%) say "no"—they say essentially that reading and math skills must be mastered first. However, nearly three-fourths of elementary teachers (71%) believe that meaningful learning can co-occur with the development of basic reading and math skills. Elementary teachers are also more likely to be comfortable with Mr. Jones' turn-back-students'-questions approach to teaching than Ms. Hill's direct instruction approach. They are also more likely to believe in having multiple project-oriented activities going on in class than teaching short-attention-span whole-class assignments. However, on most of our teacher belief questions the differences between elementary and secondary teachers are under 10 percentage points.

Why elementary teachers should be somewhat more constructivist in philosophy is probably partly due to their having a greater interest in child development per se and a lesser attachment to the knowledge base of particular subject matters. That is, the average elementary teacher may be more attentive to the mechanisms that produce *learning* and less interested in the transmission of their own *knowledge* than the average secondary teacher. Another reason may be related to structural differences in their work environment. Most elementary teachers are responsible for one group of students for most of a school day. In these self-contained classes they have a greater opportunity for flexibility in their teaching. To help clarify this issue, we split elementary teachers into those who indicated they taught self-contained classes, versus those who identified their teaching responsibilities as subject-specialists or having responsibility for two or three subjects taught to different classes of students.

We found that self-contained elementary teachers do give more constructivist-compatible responses to questions about their teaching beliefs than other elementary teachers do. For example, more self-contained elementary teachers favored Mr. Jones' inquiry-based approach (59%) than did other elementary teachers (47%). This pattern was also evident when we asked about the utility of different forms of assessment in judging how well students are learning. (See below.) Among elementary teachers of self-contained classes, 73% saw open-ended problems as being a very useful assessment tool while only 54% of other elementary teachers did. Teachers of self-contained classes were also somewhat *less* likely than other elementary teachers to believe that "a quiet classroom is generally needed for effective learning" (39% vs. 48%). Finally, when confronted with having to choose between covering standard curriculum content or instruction that encourages critical thinking and "sense-making," elementary subject-specialists chose curriculum content nearly twice as often as elementary teachers of self-contained classes (24% vs. 13%).

Differences Among Secondary Teachers by Subject Taught

Among secondary school teachers, there are a wide variety of beliefs about good teaching. Even within subjects, opinions vary. However, subject matter is among the most important predictors of teachers' opinions.

To illustrate these differences, we will show the pattern for two specific survey items: whether the teacher believes that students learn more knowledge from Mr. Jones' inquiry approach or Ms. Hill's direct instruction approach; and whether they see their role more as a facilitator for student discovery or more as the explainer ("Students really won't learn the subject unless you go over the material in a structured way.") These two survey prompts deal with the same basic difference in approach between a teacher helping students to discover knowledge for themselves and a teacher who transmits that knowledge directly to students. When one explains something, to some extent it means that all the meaningful questions have been answered—and that transmission of these answers should be the goal of instruction. However, if one believes that one cannot deeply understand something through simply receiving an explanation, one is more likely to value a teaching style that is more inquiry-oriented and constructivist.

Table 4 shows how secondary teachers of different subjects answered those two survey items. Regarding the question about the Mr. Jones' inquiry approach and Ms. Hill's direct instruction style, four groups of teachers were more likely to say that learning would be greater if students were given responsibility for investigating their own questions: English teachers, fine arts teachers, science teachers and teachers of computer classes (e.g., "Computer Applications" or "Introduction to Computers"). Teachers of the other five subjects were more likely to believe that rapid-fire delivery of questions with single correct answers is a better approach to helping students learn their subject: mathematics, social studies, foreign language, business education, and vocational education teachers. These subject differences were not small. In seven of the nine subjects, one or another of these views was clearly dominant (i.e., led the other by more than 10 percentage points).

On the more general survey item about the same issue—do the teachers see themselves as a facilitator of student work or person who explains what students need to know—the pattern was fairly similar except that vocational education teachers switched to the "constructivist side" and two other groups (social studies teachers and business education teachers) were evenly split. (One difference between the questions is that in the vignettes, Jones' class involved specifically intellectual discourse whereas in this second item the facilitation was merely of "students discovering...for themselves.") Still, even for this second item, teachers of two subjects, mathematics and foreign language were much more likely to see their teaching in terms of explaining things to students than in terms of facilitating student work.

TABLE 4: SECONDARY TEACHERS' RESPONSES TO TWO SURVEY ITEMS ABOUT CONSTRUCTIVIST VERSUS TRANSMISSION MODELS FOR APPROACHING TEACHING, BY SUBJECT MOST OFTEN TAUGHT

	Students Gain More Knowledge from Jones' or Hill's approach (remainder were undecided)		Mainly See my Role as a Facilitator or Explainer (remainder were undecided)	
Subjects Sorted by Constructivism of Responses to These Two Questions	% Jones' Inquiry Approach	% Hill's Direct Instruction	% Facilitator	% Explainer
Computer	47	39	56	24
English	52	38	46	23
Fine Arts	43	30	42	28
Science	45	32	37	32
Vocational	30	50	47	30
Business	36	52	38	37
Foreign Language	43	47	24	39
Social Studies	28	55	34	37
Math	34	49	28	43

Sample: Both probability and purposive samples. Jones-Hill question from questionnaire versions 3 and 4 only.

BELIEF INDEX SCORES

Exploratory factor analysis suggested that, like the two survey prompts just discussed, most of the items in the three survey questions about teaching philosophy could be interpreted as indicators of a common underlying construct that contrasts constructivist versus transmission and skills-practice orientations. Reliability analysis of 13 of these items produced an index with an alpha of 0.83. The following are these 13 survey items, which are expressed in constructivist terms when both poles were presented to respondents, and marked as "reversed" when the prompt asked the respondent to "agree or disagree" with a transmission-oriented statement.

- Jones' inquiry approach produces more student knowledge than Hill's direct instruction
- Jones' inquiry approach produces more student skills than Hill's direct instruction
- Believes in being a facilitator rather than explainer
- Student interest and effort is more important than textbook content
- Sense-making and thinking are more important than the specific curriculum content

- Different students engaged in different project-type activities is better than the whole class working at the same time on a series of short-duration assignments
- Students will take more initiative if they are free to move around the room
- Students should help establish the criteria on which their work is assessed
- Instruction should be built problems with clear, correct answers (reversed)
- Teachers know more than students and shouldn't let students muddle around (reversed)
- Student learning depends on background knowledge — that's why teaching facts is so necessary (reversed)
- It is better for the teacher, not students, to decide what activities are to be done (reversed)
- A quiet classroom is generally needed for effective learning (reversed)

Overall, across these 13 items, teachers of elementary grades are somewhat more constructivist in philosophy than other teachers are (particularly those who teach self-contained classes), and high school teachers are somewhat less constructivist than other teachers. By subject matter, two groups of secondary teachers have more constructivist philosophies than do others: English teachers and a relatively small group of primarily middle-grades teachers who teach a variety of academic subjects. (See Table 5.) Three groups of secondary teachers are generally less constructivist than are others: social studies teachers, math teachers, and foreign language teachers. Teachers of those subjects more often agree with the "traditional" transmission-oriented views of instruction. (Secondary science teachers tend to be squarely in the middle.) Among non-academic or "applied" subjects, computer teachers had views slightly on the constructivist side, while the business education and fine arts teachers in our national sample are clearly transmission-oriented in their beliefs.

TABLE 5: AVERAGE TEACHER BELIEF INDEX Z-SCORES BY SUBJECT AND LEVEL

	Elementary Grades	Middle Grades	High School Grades	Both Secondary Levels
Secondary "Academic"				
English	-	0.08	**0.47**	**0.27**
Science	-	0.23	−0.13	0.02
Math	-	−0.19	**−0.40**	**−0.29**
Social Studies	-	**−0.44**	−0.17	**−0.31**
Foreign Language	-	**−0.72**	−0.25	**−0.46**
Mixed & Other Academic Secondary	-	**0.52**	−0.34	**0.40**
Secondary "Applied"				
Computers	-	0.37	−0.18	0.08
Other Secondary Applied	-	−0.16	0.20	0.06
Vocational	-	−0.24	−0.06	−0.12
Business	-	**−0.48**	−0.21	−0.25
Fine Arts	-	**−0.56**	−0.01	−0.28
Elementary				
"Self-contained"	0.17	-	-	-
"Other"	0.10	-	-	-
All Subjects	0.15	−0.02	−0.07	−0.05

Note. Z-scores across all teachers in probability sample (Mean = 0.00, s.d. = 1.00). Cells for which a relatively high mean z-score minus one standard error of that mean remains **above +0.20** and cells whose (relatively low) mean z-score plus one standard error of that mean remains **below −0.20** are highlighted in the table. Additionally, where the difference between high school and middle school means is greater than the sum of their standard errors, a box is drawn around the level with the more constructivist beliefs.

Although, on average, middle school teachers have slightly more constructivist beliefs than high school teachers do, the patterns are quite different for different subjects. For some subjects, notably those of the

more qualitative sort, high school teachers are more constructivist. For example, it is primarily high school English teachers, not middle school, who hold strongly constructivist beliefs—among the strongest of any group in our sample. Furthermore, in several of the subjects where transmission-oriented views predominate—social studies, foreign language, and fine arts—it is at the middle school level where transmission-oriented views are particularly strong; high school teachers of those subjects are much closer to the middle of the teaching philosophy distribution. On the other hand, in the more technical and quantitative subjects of science, mathematics, and computer education, middle school teachers are more inquiry-oriented (constructivist) than their high school teacher peers. In fact, high school math teachers are more transmission-oriented than any other group of high school teachers in our national sample.

How would we account for these different patterns of belief by teachers in different subjects, and why do such contrasting patterns prevail between middle and high school teachers in different subjects? To explain subject-matter differences, and to some extent differences in level as well, one has to consider the nature of the curriculum in the different subjects. In areas (subjects and levels) where the most salient competencies are conceptual ones, teachers are more apt to see student learning as arising from engagement in issues in which the student has a personal interest. Conceptual learning seems to demand an approach that facilitates the emergence of student understanding from their continued intellectual engagement with the subject. Conversely, in areas where the most salient competencies are defined as involving procedural and factual knowledge, teachers may be more inclined towards direct explanation and an emphasis on "clear, correct answers." Of course every field of study could be approached from either a conceptual or procedural direction. However, every field has a characteristically normative set of beliefs about the appropriate timing of attention to procedural knowledge and conceptual understanding. Differences in teaching philosophies across fields, and across levels within fields, may largely come from parallel differences in those curriculum-based beliefs.

In addition, differences in philosophies within a subject between middle grade and high school teachers may also be due to other factors that operate differentially across subjects. Older students' more developed abilities to reason independently and critically about complex issues might lead high school teachers to believe more in the kind of teaching that provides latitude to students; however, such views are likely to prevail only in those subject areas where reasoning is valued relative to skills or knowledge acquisition. On the other hand, high school teachers of some subjects may feel a greater sense of ownership in the knowledge base that exists in their field (or a greater sense of pressure to prepare their students for college admission), and may therefore feel a greater desire to directly convey that knowledge base to their students. Overall, then, the specific strength of these forces—internal or external pressure to cover curriculum versus expectations for more independent thinking by students—may explain why for some subjects, teachers' philosophies appear to be more constructivist among middle grades teachers while for other subjects, more constructivist philosophies prevail among high school teachers.

We will return to these issues later in this report, after we examine in detail specific instructional practices of teachers of different subjects, and the extent to which those classroom practices reflect a constructivist or a transmission-oriented pedagogy. However, before discussing teachers' practices, we need to examine one other area regarding teachers' beliefs—their judgments about the usefulness of different forms of assessment in deciding how well students are learning.

BELIEFS ABOUT METHODS OF ASSESSING STUDENT LEARNING

Teachers choose from an array of methods to evaluate their students' acquisition of competencies and knowledge. These methods range from brief self-constructed short-answer quizzes and externally designed (i.e., "standardized") multiple-choice tests all the way to small group and individual research projects several weeks in the making. A teacher's choice of assessment methods is one way in which she implements a teaching philosophy, and constitutes one element of her actual classroom practice. However, rather than asking teachers about their actual assessment practices, the TLC survey asked teachers to evaluate the usefulness of different methods of assessing student learning. Those judgments constitute another aspect of teaching philosophy.

Given the widespread use in schools of short-answer and multiple-choice tests (including those provided to teachers by textbook publishers), and given the widespread discussion in the policy community about the use of externally designed standardized multiple-choice tests for accountability purposes, it is important to note that most teachers do not find those approaches as "useful...in judging how well students are learning" as others in their repertoire. Overall, among the six assessment methods the teachers were asked to rate in terms of usefulness for themselves, the three judged most useful were student presentations and performances, individual and group projects, and open-ended problems. By far the least useful method, in the view of teachers, was standardized test results, and the next least useful was "short-answer and multiple-choice tests." In fact, in not a single academic subject did teachers say that standardized tests, short answer, or multiple choice assessments were among the most useful assessments available to them. In every subject, project work, student performances, and open-ended problems were viewed as being more useful than either short-answer/multiple-choice tests or standardized test results. (See Table 6.)

TABLE 6: PERCENT OF TEACHERS REPORTING EACH KIND OF ASSESSMENT IS "VERY USEFUL IN JUDGING HOW WELL STUDENTS ARE LEARNING."

		Middle and High School Grades					
	Elementary	English	Social Studies	Science	Math	Other Secondary	Total
Student presentations and performances	75	75	69	59	53	80	71
Open-ended problems	67	74	58	65	60	68	66
Individual and group projects	74	64	54	61	44	72	65
Essay tests	58	79	69	55	28	54	56
Short-answer and multiple-choice tests	41	23	44	38	40	34	36
Standardized test results	14	13	18	9	22	14	15

Sample: Probability sample.

As one would expect, there is an association between valuing student presentations, projects, and open-ended problem-solving and constructivist teaching philosophies; and, conversely, valuing short-answer/multiple choice tests and standardized tests and a transmission-oriented philosophy. (See Table 7.)

TABLE 7: CORRELATIONS BETWEEN BELIEF INDEX AND USEFULNESS OF DIFFERENT KINDS OF ASSESSMENT

Student presentations/performances	.36
Individual and group projects	.36
Open-ended problems	.33
Essay tests	.06
Standardized test results	−.20
Short-answer and multiple-choice	−.35

Sample: Probability sample.

These findings suggest that, as a group and in every subject, a large majority of teachers believe that if the purpose of assessing students is to find out how well students are learning, then assessment should be based on providing students with opportunities to demonstrate and communicate their understandings and ability to solve problems rather than on the basis of seeing which answers they select from a list or what factual information they can recall. This result reinforces the position that teachers have primarily constructivist viewpoints about teaching and learning.

Critics of standardized testing and advocates of alternative assessment strategies should be encouraged by these findings. They illustrate that, to a large extent, *teachers* also question the utility not only of standardized tests, but even the short-answer and multiple-choice style tests that textbook publishers provide to them and that they create themselves, constrained by limited time and the need to have *some* measurement on the 150 students they teach. For people who are concerned about testing policies and that element of the "reform" movement based on the idea of keeping teachers and students accountable through standardized test comparisons, it is important to recognize that teachers themselves seem to be fairly cognizant of the limitations of the kind of testing practices that such an accountability system would promulgate.

PART II. CONSTRUCTIVIST-COMPATIBLE TEACHING PRACTICES

TEACHING PRACTICES AND TEACHING PHILOSOPHY

In the previous section, we examined a number of beliefs about teaching and learning that together reflect a philosophy, which we argue, is compatible with constructivist learning theory. However, carrying out a teaching practice based totally on such beliefs is *anything but easy* to accomplish. Even when teachers have constructivist beliefs, limitations coming from (a) the strain of being responsible for entire classrooms of individual students at the same time, (b) inadequacies in their own knowledge of content or pedagogy, (c) competing objectives that they may have themselves, or (d) external pressures on what they must do in the classroom—all of these forces interfere with the implementation of a constructivist philosophy. What *is* implemented, based on what is relatively easy to implement and what draws less interference from competing forces, often bears only a superficial resemblance to the philosophy that a teacher may espouse.

For example, a fairly consistent theme in the literature on school improvement is the notion that broad coverage of a large number of topics does not permit students to engage a given issue deeply enough to generate a web of connected and meaningful understandings. If constructivist-believing teachers have other objectives that include, for example, broad coverage of diverse content (whether personally valued or because of outside pressures), then those teachers will inevitably fail to be as constructivist in practice as in philosophy. In fact, one question in the survey asked teachers to characterize the number of topics (themes, units, chapters) that they cover in one class—the class in which they actually feel they most often achieve their teaching objectives. Only 7% of teachers surveyed reported covering a small number of topics in great depth in that class, while one-half (actually, at least 50% in *every* subject) reported covering a large or very large number of topics without going into very much depth.

CONSTRUCTIVIST-COMPATIBLE TEACHING PRACTICES

The central element of constructivist learning theory is that learning occurs when a student is deeply engaged with an intellectual issue. According to this theory, learning occurs only when students make an effort to construct their own understanding out of a problem situation. Moreover, student effort occurs primarily around learning tasks that students regard as meaningful. That is, although teachers can get students to do schoolwork by using various sanctions and incentives, constructivism maintains that deep understanding only occurs if students are motivated by a desire to understand and that that motivation is much more likely if (a) she already has an interest in and some knowledge of the content and (b) if the content is made "accessible" to the student by somehow making explicit connections to the student's current perspective or understandings. Teaching that organizes student work around meaningful activities so that students are thoughtfully engaged with content is the heart of a constructivist teaching practice.

Thoughtful engagement with content would be expected, for example, if students are required to monitor their own learning experience as part of their class work. Examples of meaningful self-monitoring would include writing about their own work, considering multiple potentially valid alternatives, helping to plan classroom activities, designing their own problems to solve, or undertaking tasks where there is not a clear "correct" answer ahead of time. Other examples of teaching practices which suggest that students are thoughtfully engaged in intellectual work include frequent writing assignments of a reflective nature, having students make conjectures to explain things and backing up those conjectures with reasoning and evidence, and expressing the same idea in multiple forms. These are among the operational indicators we use to define a constructivist-compatible teaching practice.

Other teaching practices are also compatible with constructivism but do not appear to be inevitably associated with a constructivist philosophy—practices such as having students work in groups, do laboratory activities, or work on complex projects on a single topic. That is, we do not automatically conclude that teachers' use of these practices means that their principal intent is that students be thoughtfully engaged with content in the same way that we are willing to assume that thoughtful engagement is the goal of reflective writing assignments or asking students to make conjectures. Projects and small group work can be assigned without attention to deep intellectual engagement; they are activities that teachers can, to some extent, be expected to report whether or not they are particularly constructivist. In sum, they may be assigned and carried out without being intellectually challenging.

The question of the intellectual engagement occurring in these common "constructivist-compatible" activities is therefore important to address. In what settings do projects and group-work provide a vehicle for meaningful student engagement?

Thus, although our study describes a variety of teaching practices associated with a constructivist-compatible teaching practice, we define certain practices—the ones most directly linked with student intellectual engagement (meaningful thinking)—as central, while other practices—notably the use of projects and group activities—we define as probabilistically indicative of a constructivist practice. The following section discusses 27 teaching practices—how they are conceptualized, how they are related to one another, and how they are distributed across school levels and subjects. The section is divided into five main groups of survey items: (1) indicators of "meaningful thinking" teaching practices including reflective writing; (2) indicators of "problem-solving"; (3) indicators of teaching using "group-work"; (4) indicators of a "project-based" approach to teaching; and (5) indicators of a traditional, transmission- and skills-oriented teaching practice.

Each indicator (survey item) is uniquely assigned[4] to one of these categories, based on a large number of exploratory factor analytic investigations.[5] We find that our particular categorization of the 27 indicators is useful and defensible statistically, but we make no claim that this typology and our assignment of survey items has more than heuristic value. Figure 3 lists each of the 27 survey items discussed in this section, according to the category to which we assigned it. Appendix D presents the distribution of responses by teachers in the national probability sample to each of the items in the five survey questions that were used to develop the dimensions of teaching practice examined and the overall Constructivist Pedagogy Index.

One other point. When we compare teachers of different subjects on these indices of instructional practice, as we do below, we sometimes find substantial differences in the average scores of teachers in different subjects. Although we are aware that specific instructional practices are differentially relevant to the teaching of different subjects, we believe that, for the most part, differences across teaching subjects in average index scores reflect real differences in the constructivism of teaching practices experienced by

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[4] One survey item, "work in small groups to come up with a joint solution or approach to a problem or task," is included in both the "group-work" and "problem-solving" measures.

[5] Survey items that had low communalities during initial factor analyses were excluded for subsequent analyses. We did not use factor scores in this study, but used factor analysis as a technique for decisions about item inclusion in indices. We used oblique rotation within a principal axis factoring method because we envisioned the different types of practice, while distinct, to be nonetheless related and therefore not orthogonal constructs. Belief items, when they were included, almost always loaded on separate factors from practice items, in contrast to the findings of the preliminary validation study. In general, it was during this stage that we observed that project-related items were least well correlated with the other practice items; i.e., always producing their own factor. In contrast, reflective writing and the other meaningful thinking items appeared to be very closely related. Group-work items tended to load with the meaningful thinking items, pointing to a possible contrast between projects and group work in how each relates to the level of cognitive challenge in a classroom.

students in classes in these subjects. At the same time, differences in mean scores by subject may also reflect the particular survey items selected to measure each aspect of instructional practice. Without further investigation, it is difficult to know which of these two explanations is more appropriate for any given comparison. Consequently, as a conservative approach, in this report we pay more attention to differences among teachers of the same subject than to the overall differences among teachers across all subjects.

FIGURE 3: SURVEY ITEMS MEASURING CONSTRUCTIVIST PRACTICE

COGNITIVE CHALLENGE			ACTIVE LEARNING STRATEGIES		
MEANINGFUL THINKING					
Deep Thinking and Probing Questions	Reflective Writing	Problem Solving	Projects	Group Work	Transmission-Oriented (Reversed)
When introducing a unit, did the teacher ask students to make conjectures about issues she introduced? When introducing a unit, did the teacher raise questions about the unit that she did not know the answer to? How much time in the last 5 class hours did students spend leading a discussion or making a presentation? Reason teachers asked questions: Was it to... ...Elicit students' ideas and opinions? ...Get students to justify and explain their reasoning? ...Have students relate what they were working on to their own experience? How often were there tasks where students... ...Suggested or helped to plan classroom activities or topics? ...Debated and argued a point of view, perhaps not their own? ...Represented the same idea or relationship in more than one way? ...Worked on tasks with no indisputably correct answer?	How often did students... ...Write in journal? ...Write an essay explaining their thoughts at length? ...Write an essay about or seriously assess their own work?	How often did students... ...Work on problems for which there was no obvious method of solution? ...Have to design their own problems to solve? ...Decide on their own procedures for solving a complex problem and then discuss results?	How often did students... ...Do hands-on/ laboratory activities? ...Work on projects that take a week or more? ...Make a product to be used by someone else? ...Demonstrate their work to an audience including people other than from the school or their family?	When introducing a unit, did students discuss the topic in groups? How much time in last 5 class hours did students spend working together in small groups to complete assignment as team? How often did students work in small groups to come up with a joint solution or approach to a problem or task? (also in Problem-Solving, but excluded from Cognitive Challenge)	When introducing a unit, did students do introductory drills on skills and facts? How much time did teacher spend leading a whole-class discussion (students listened and answered questions)? How often did teacher ask questions to see if students know the correct answer? How often did students work individually answering questions in the textbook or on worksheets?

COGNITIVELY CHALLENGING TEACHING PRACTICES

Three groups of survey items comprise our measure of the degree of emphasis placed by a teacher on providing a cognitively challenging experience for students. Of course, what is cognitively challenging for one student may be routine and even boring for another. However, as distinct from emphasizing skill- and knowledge-transmission activities, some teachers emphasized reflective writing, tasks requiring deep thinking (such as asking students probing questions), and problem-solving tasks. While in some factor analyses, problem-solving items loaded on a different statistical factor from the others, the items classified as reflective writing and those called "deep thinking" differed primarily in terms of the content of the activity. Together, the reflective writing and deep thinking items are referred to here as "meaningful thinking" teaching practices.

Reflective Writing

Perhaps the most powerful indicator of meaningful intellectual engagement is writing in which students are expected to draw connections between ideas themselves. The three types of writing assignments we asked about were writing in journals, writing of reflective essays, and writing an analysis of the quality of their own work.[6] Teachers who engage their students in these reflective writing activities, regardless of subject, also tend to assign other types of meaningful tasks. What types of reflective writing activities are reported across subjects, and which type of writing is most common?

Of the three types of reflective writing, the most commonly reported was writing essays in which students "are expected to explain their thinking or reasoning at some length." One half of all teachers, across all subjects, reported assigning essays of this type on at least a monthly basis, and nearly one-quarter (22%) reported assigning reflective essays on a weekly basis. Fewer teachers had students do any journal writing at all, but of those who did, more teachers had students do journal-writing on a weekly basis (28% of all teachers). Written self-assessment was by far the least frequent of these three methods.

Not surprisingly, reflective writing assignments are much more common in English classes than in other subjects. In fact, in the secondary grades, more than a third of all essay and journal writing that was reported took place in English classes. (See Appendix Table A-1.) Aside from English classes, the secondary subjects where essays are most likely to be assigned are science and social studies. Elementary teachers of self-contained classes also report frequent journal writing by students.[7] For example, 58% of elementary self-contained and 51% of English teachers have students write in a journal at least once per week, compared to only 14 to 15% of science and social studies teachers. Among applied subjects, vocational teachers appear to be more likely to have students do journal writing than in other subjects; 26% report students keeping a monthly journal compared to only 5% of business teachers. However, there are only small differences in the other types of writing in these subjects.

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[6] The self-assessment item also incorporated "serious discussion" among students as well as written assessments.

[7] Of course, teachers of self-contained classes have their students in class for many more hours per week (and are the primary source of their students' home assignments).

In some subjects, there were large differences between middle and high school teachers' use of reflective writing assignments. Middle school teachers reported substantially more writing activities in science, computer education and mathematics. For example, 34% of middle school science teachers said students wrote in a journal compared to 9% of high school science teachers. In applied subjects, the pattern was the same. Almost half of middle school computer teachers said they had students write essays monthly (47%) compared to 13% of high school computer teachers. (See Appendix Table A-2.)

TABLE 8: PREVALENCE OF REFLECTIVE WRITING ACTIVITIES BY SUBJECT TAUGHT

	Percent Reporting Monthly Writing by Students			
Rank of Subjects by Reflective Writing Scores	Essay Explaining Thoughts at Length	Write in Journal	Essay or Discussion Seriously Assessing Own Work	Reflective Writing mean Z-score
English	82	59	54	0.71
Elementary Self-contained	64	65	42	0.59
Elementary Other	44	37	33	0.05
Social Studies	67	21	35	0.02
Science	49	20	21	– 0.18
Foreign Language (HS)*	47	17	44	– 0.32
Vocational	25	26	20	– 0.45
Computers	30	16	21	– 0.51
Business (HS)	31	4	28	– 0.62
Math	24	18	10	– 0.66
Fine arts	15	9	27	– 0.68
All Teachers	50	35	31	

Sample: Probability sample.
*HS = high school.

Tasks and Questions Calling for Deep Thinking

While reflective writing is clearly one way of promoting meaningful thinking around an activity, many other approaches are used, particularly in subjects where writing is less a primary objective of the subject matter than in English. Additional activities we view as providing an indication of meaningful student engagement include (a) the types of questions teachers ask, (b) how they introduce new topics (e.g., by having students make conjectures), and (c) how classroom time is spent (e.g., in student-led vs. teacher-led discussions).[8]

Questions without Answers:

One key question we can ask about the intellectual nature of classroom activity is whether or not student work is built around questions or tasks for which the teacher has a clear, pre-ordained "correct" answer in mind. Where objectively knowable "right answers" prevail, students who are making an effort may be focused on finding out the teacher's answer ("what am I supposed to

[8] Many people would regard teacher-led discussion as no less likely to promote meaningful thinking than student-led discussion. This may be the case, although for the students who are presenting to their peers, the requirement to communicate with an audience would seem to make greater thoughtfulness more likely for them. Overall, in our data, frequency of student-led discussions is positively associated with other elements of cognitive challenge, such as reflective writing and problem-solving, whereas frequent teacher-led discussions is negatively correlated with those elements.

learn?") and be less inclined towards achieving a personal mastery and deep understanding of the larger content under study ("what do I think or understand about this issue?"). Teachers of different subjects vary quite a bit in terms of the nature of the questions they ask students and the ambiguity of what counts as knowledge, but overall relatively few teachers reported having frequent discussions where the knowledge at issue involved much ambiguity. When asked how often how they give assignments "where there is no indisputably correct answer—where truth is complex and perhaps impossible to know," only 7% of teachers said they did this on a weekly basis and only 23% said they did this at least monthly. The subject where teachers were *least* likely to teach in this way was business education (none weekly and only 10% monthly) and mathematics (1% weekly; 11% monthly). In comparison, about 40% of English and fine arts teachers reported organizing student work around tasks where truth was inherently ambiguous.

A similar indicator that most teachers' pedagogies are structured around presenting truths rather than students constructing their individual understandings comes from a question about how teachers introduce a unit of instruction. We asked teachers whether, at the outset of a unit, they raised questions to which they themselves did not know the answer, an approach that might allow them to model the development of understanding. Do many teachers present themselves as learners, raising problematic questions with respect to their own knowledge? Overall, fewer than one-quarter of teachers said that in introducing their current unit, they had brought up questions to which they didn't know the answer. In particular, very few business education teachers did this (5%), far fewer than did teachers in other fields.

An additional note about the validity of this survey's data on teaching practices. As discussed earlier in the report, writers such as Cuban (1993) and Kennedy (1999) have questioned whether teachers' survey responses to general questions about their instruction accurately portrays the frequency that they carry out particular teaching practices. Cuban, in particular, argues that in-depth observation of teachers in classrooms yields a conclusion that typical practice is much more traditional and fact- and skill-oriented than is suggested by teachers' survey responses. However, we find that teachers' responses vary a great deal according to specific practices that they are asked about. The findings of the preceding paragraphs, in particular, suggest that very few teachers report employing approaches that seem fairly central to a constructivist practice—giving students tasks related to problems that lack clear, correct answers and modeling the role of learner and by admitting to ignorance of important issues in an upcoming curricular unit. The distribution of answers to these two survey questions, and others with similarly "traditional" modal responses is evidence that teachers' survey self-reports may be a fairly honest reflection of their teaching practice—and that despite having fairly constructivist beliefs about what constitutes good teaching, most teachers employ only some teaching strategies in pursuit of a constructivist teaching philosophy.

Other Questions Teachers Ask of Students:

Virtually all teachers can be expected to spend some time leading whole-class discussions in which they ask students questions of various sorts. But the nature of whole-class discussion is open to variation. Here we examine a few different types of questions teachers ask groups of students and *what their goals are* in asking students questions. We asked how often teachers are trying to accomplish the following goals—seeing if students know the correct answer; seeing if they have done homework; eliciting student ideas or opinions; getting students to justify or explain their reasoning; and, having students relate what they are working on to their own experiences.

All teachers at least occasionally ask students questions to see if they know the correct answer, and half of the respondents in our survey said they did this "very often" or "always." Fewer teachers reported asking students questions to see if homework had been done; however, a clear majority of foreign language teachers and almost exactly half of business education teachers said they asked questions to check homework "very often." Although this highlights the traditional approach of these teachers, across all subjects the most frequently reported reasons for asking questions are those that would help provide the teacher with insights into their students' thinking—going beyond just whether the students know the right answer.

Asking questions that elicit students' own ideas is one of the more common, and probably less difficult, ways of engendering interest and thoughtfulness in a class of students. A large majority of teachers reported that they "very often" asked students questions in order to elicit their ideas. Similarly, most teachers said they asked questions to get students to justify their reasoning, and a majority of teachers said they asked questions that asked students to relate ideas to their own experiences. (See Table 9.) More teachers reported asking those kinds of questions than said they asked questions in order to see if students knew the correct answer or to see if they had done their homework. However, compared to other subjects, math and business education teachers were less likely to ask questions in order to elicit student ideas and opinions. Perhaps teachers in those subjects more often feel that students do not have the requisite knowledge to have formed "useful" opinions, compared to English and social studies, where students have more personal experience in the subject which they can draw upon.

TABLE 9: REASONS TEACHERS GIVE FOR ASKING STUDENTS QUESTIONS, BY SUBJECT TAUGHT

	Percent Asking Question for this Purpose Very Often or Always				
	Ask for the correct answer	Check if students did homework	Have students justify or explain their reasoning	Elicit student ideas and opinion	Have students relate work to their own experience
English	42	27	80	76	68
Social Studies	52	33	65	70	55
Science	48	30	77	61	54
Math	66	39	88	55	37
Foreign Language	75	57	53	73	53
Computers	54	27	56	59	48
Business	71	49	73	53	50
Vocational	42	26	65	61	62
Fine arts	46	16	63	65	49
Elem. Self-contained	53	33	81	78	69
Total	53	32	76	69	57

Sample: Probability sample.

When we look at middle school versus high school patterns of question-asking by subject, in some cases it is the high school teachers who ask for more probing questions; in some cases, it is the middle school teachers. High school English teachers generally appear to be more constructivist than middle school teachers in their question-asking practices—much less frequently looking for correct answers (29% of high school vs. 52% of middle school teachers saying they did this "very often") and more often asking students to justify or explain their reasoning. This pattern may be due to the greater focus on skills instruction in middle school English and a greater focus on literature in high school. (See Appendix Table A-3.)

Similarly, among social studies teachers, high school teachers pursued more probing questions than did their middle school counterparts. Three-quarters of social studies teachers at the high school level (76%) reported asking students to justify or explain their reasoning very often,

compared to only 57% of middle school social studies teachers. More than three-fifths at the high school level (62%) asked students to relate work to their own experience, compared to 49% of middle school social studies teachers. Thus, at least in this respect, high school social studies and English teachers appear to be more constructivist than middle school teachers of the same subjects.

In mathematics, the pattern is reversed. Middle school math teachers were more likely to report having their students justify or explain their reasoning than were high school math teachers (93% vs. 80%) and more likely to say they had students relate their work to the students' own experiences "very often" (47% vs. 26%; see Appendix Table A-3.)

The survey asked teachers about one other questioning strategy. We asked respondents whether, in introducing a new unit to students, they questioned students in order to get them to make conjectures about the topic of the unit. This is an approach that can activate students' existing related knowledge and opinions and can uncover student interests and preconceptions about the topic. Overall, half of all teachers in our study indicated that they asked students to make conjectures when they introduced the current unit. About two-thirds of elementary and English teachers reported doing this. However, teachers of some other academic subjects—specifically mathematics and social studies teachers—were among the *least likely* to ask students to do this kind of preliminary thinking and hypothesizing.

Several other survey items reflecting practices that prioritize meaningful thinking were included in the survey: for example, holding debates where students argued from viewpoints that may not be their own, having students address the same issue in different ways (multiple representations), and having students themselves plan classroom activities. Each of these tends to place responsibility for creating knowledge in the hands of students. Holding debates where students argue a point of view that may not be their own forces students to view different sides of an issue and to use evidence in support of taking a position. Only 12% of teachers overall reported using this practice even on a monthly basis; the most frequent affirmative responses were given by social studies teachers (24%). Use of multiple representations was reported by about one-half of teachers in each of the academic subjects, but only between one-quarter and one-third of "applied" teachers. Students "helped to plan learning activities" in about one-quarter of all their classes, most often in English (38%) and *least* often in science (17%), math (12%) and business (10%) classes.

Index of Meaningful Thinking

In every school subject there is a high correlation among reflective writing tasks, teachers asking probing questions, and other tasks requiring relatively deep thinking. That is, *within a subject* the teachers who do more reflective writing also report more of the other thinking tasks as well, and vice versa. Taking each subject separately, the correlation between the reflective writing index (comprised of three items) and an index comprised of 10 other deep thinking tasks (see below) is greater than 0.45 for elementary, social studies, English, and science teachers. (The correlation coefficients are presented in Appendix Table A-4.) Because of this pattern, we created a combined measure of "meaningful thinking" that is based on teachers' scores on reflective writing and on the other tasks and questions calling for deep thinking that we asked about. Combining these items for use as a criterion measure was strongly supported by empirical analysis—e.g., the items consistently loaded together in factor analysis. The alpha reliability of the scale, for example, was 0.81. Corrected item-total correlations were all in the range of 0.30 to 0.60. More importantly, we think that, *conceptually,* an index of these items makes sense, and, as suggested

earlier, we regard an emphasis on meaningful thinking as *the* central aspect of constructivist-compatible teaching practice.

TABLE 10: FREQUENCY OF MEANINGFUL THINKING BY SUBJECT AND LEVEL TAUGHT (INDEX MEAN Z-SCORE)

Ranking by Subject & Level*	Mean Z-Score on Meaningful Thinking Index (13 items)
English (HS)	0.68
English (MS)	0.45
Elementary	0.34
Social Studies (HS)	0.19
Science (MS)	– 0.03
Social Studies (MS)	– 0.16
Vocational (All)	– 0.26
Science (HS)	– 0.27
Foreign Language (All)	– 0.27
Math (MS)	– 0.32
Computer (All)	– 0.50
Fine Arts (All)	– 0.66
Math (HS)	– 0.66
Business (All)	– 0.71
All Teachers	0.01

Sample: Probability sample.
*MS = middle school, HS = high school.

Overall, English teachers appear more likely to assign work that would generate meaningful thinking than any other group of secondary teachers. Only elementary teachers approach English teachers in this respect. However, elementary teachers' scores are difficult to compare with secondary teachers' because most of the items are "frequency-based" (i.e., estimates of how often different practices occur) and most elementary teachers teach the same students for a full day, far longer than secondary teachers who generally teach classes for only 50-minute periods.

Three of the four groups of teachers who report the least frequent use of these reflective writing, probing questions, and deep thinking tasks teach subjects that are applied in nature rather than strictly academic—computer teachers, business education teachers, and fine arts teachers. However, high school math teachers also fall in this group, and even when we use a broader definition of higher-order thinking that incorporates problem-solving (see below), the typical high school math teacher still appears to put less of an emphasis on cognitive engagement than other teachers do.

Problem-Solving Activities

Problem-solving involves a *more-or-less* cognitively challenging activity that can also be *more or less* meaningful. In other words, the construct of problem-solving *could* include students solving routine algorithmic problems in a workbook. However, the particular aspects of problem-solving which are included in the TLC questionnaires—students working on problems with no obvious solution, deciding on their own problems to solve, and deciding on their own procedures to try—clearly are cognitively challenging. We expected that teachers who reported more of these types of problem-solving activities also would report more of the other forms of meaningful student engagement.

Not many teachers report that they have students do this kind of challenging problem-solving very often. Only a minority of teachers—fewer than two out of five—report that they have students work on problems with no obvious solution even on a monthly basis. About the same proportion say they have students develop their own procedures for solving a problem and then discuss what they did with their peers. Fewer teachers, only one-fifth, have students design their own problems to solve, as often as once per month. These statistics suggest that most student work in classrooms is closely prescribed, focused on factual knowledge or specific skills, and is teacher-designed.

Generally, we would expect math teachers to be among those who report the most involvement in problem-solving activities. However, this is true only in one respect: math teachers are more likely than other teachers to report having students decide on their own procedures for solving a problem and then discuss results with their classmates. On the other types of problem-solving (working on problems with no obvious method of solution; and solving problems by their own procedures), math teachers were not distinctly different from science, English, and social studies teachers. The one exception is that social studies teachers much less often reported having students design their own problems to solve (only 8%, combining middle and high school teachers).

For subjects where there are a sufficient number of teachers at both middle and high school levels, Table 11 presents information about subject-specific use of problem-solving strategies by level. Middle school math teachers are more likely than high school teachers to have students work on problems with no obvious method of solution (42% vs. 31%), and are also more likely to have students decide on their own procedures and discuss results among themselves (57% vs. 40%). For vocational teachers, the pattern was reversed, with high school teachers reporting more problem-solving activities.

TABLE 11: FREQUENCY OF PROBLEM-SOLVING ACTIVITIES BY SUBJECT AND LEVEL TAUGHT

	Percent of teachers reporting students at least monthly...			
Ranking by Subject & Level*	Work on problems with no obvious method of solution	Design their own problems to solve	Decide on their own procedures & discuss	Mean Z-Score on Problem-Solving Index (4 items)
Math (MS)	42	24	57	0.33
Vocational (All)	28	42	47	0.27
Elementary	40	27	46	0.25
Science (MS)	34	21	36	0.14
Math (HS)	31	18	40	0.03
Computers (All)	34	37	54	0.02
English (HS)	42	21	35	– 0.01
Science (HS)	36	20	32	– 0.09
Social Studies (HS)	46	6	26	– 0.17
English (MS)	26	11	26	– 0.27
Fine Arts (All)	37	22	21	– 0.32
Social Studies (MS)	26	11	35	– 0.51
Foreign Language (All)	10	17	9	– 0.58
Business (All)	9	10	23	– 0.78
All Teachers	35	21	38	0.01

Sample: Probability sample.
*MS = middle school, HS = high school.

Table 11 also has a summary column showing the average score of teachers in each level-subject combination on an overall Problem-Solving Index.[9] Overall, middle school mathematics, secondary vocational, and elementary teachers report the highest average scores while middle school social studies, secondary foreign language, and business education teachers have the lowest average scores on Problem-Solving.

Problem-Solving and Use of other Meaningful Thinking Strategies

Although in our exploratory factor analyses, the problem-solving items generally loaded on a separate factor from the other items labeled Meaningful Thinking, teachers who use problem-solving strategies are much more likely to also use other thinking strategies as well. Table 12 provides data, by subject and level, on the extent to which users and non-users of each problem-solving activity differ in terms of their use of meaningful thinking strategies. The measure used in this and subsequent tables is the effect size (E.S.)—the difference in mean scores between two groups of teachers on the criterion measure (in this case, the teacher's Meaningful Thinking score), in standard deviation units.[10] In addition to comparing users and non-users of specific problem-solving activities, Table 12 provides comparisons between teachers who were above and below the median on an index that combines frequency-of-use data on all four problem-solving activities, including one not shown in the table. The effect size statistic for the overall problem-solving index measures how much teachers who are above the median on problem solving also report engaging students in meaningful thinking activities compared to other teachers of the same subject and level who do less problem-solving.[11]

Table 12 shows that in every subject, the teachers who report more problem-solving activities are much more likely to report engaging students in meaningful thinking. The effect size is higher than +0.6 for every subject, and greater than +0.9 for the major academic subjects. For example, the middle school math teachers who are above the median on Problem Solving are 1.0 standard deviations higher on Meaningful Thinking than the middle school math teachers below the median on Problem Solving. That translates into a difference of roughly 40 percentile points. All three problem-solving items shown (students deciding own procedures, problems with no obvious solution, designing their own problems to solve) had equally large effect sizes on meaningful thinking.[12]

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[9] The Problem-Solving index, like others developed here, combines scores on component survey items (four items in this case, including one not shown in the Table), by standardizing each component item before taking the mean across items. The transformation to z-scores shown similarly maintains a constant level of variability across indices for purposes of comparing across different measures.

[10] The particular Meaningful Thinking score used is the within-subject z-score, defined so that the average score for every subject is set at 0 with a standard deviation of 1.

[11] Another way of presenting the same information is through correlation coefficients between Problem-Solving and Meaningful Thinking. Those are shown in Appendix Table A-4.

[12] Another interpretation of the positive correlation between Meaningful Thinking scores and Problem-Solving scores (or between any pairs of measures that are based on "frequency" estimates or similar Likert scales is that the association is a function of different questionnaire response styles among teachers. That is, some teachers are more likely to give higher frequency estimates than other teachers are, regardless of the item prompt. Such response styles no doubt play a role. However, the size of these associations—most of those reported involve effect sizes above 0.5—suggest that more than response styles are at work here.

TABLE 12: EFFECT SIZE OF PROBLEM-SOLVING ON MEANINGFUL THINKING

Ranking by Subject & Level*	Meaningful Thinking E.S. by Problem-Solving Practice (at least monthly use vs. non-users)			Meaningful Thinking E.S. by Problem-Solving Index (Top 50% on index vs. bottom 50%)
	Design their own problems to solve	Decide on their own procedures & discuss	Work on problems with no obvious method of solution	
Math (MS)	1.1	0.9	0.7	1.0
Vocational (All)	0.5	1.0	0.4	0.6
Elementary	0.8	0.7	0.8	0.9
Science (MS)	0.9	1.0	0.9	1.1
Computer (MS)	0.5	0.5	0.6	0.7
Math (HS)	1.2	0.8	0.7	0.9
Computers (All)	0.7	0.9	0.4	0.9
English (HS)	0.9	1.0	1.0	1.1
Computer (HS)	0.9	1.2	0.5	1.1
Science (HS)	0.7	1.0	0.9	1.0
Social Studies (HS)	1.2	1.2	1.1	1.1
English (MS)	0.6	0.9	0.9	1.0
Fine Arts (All)	0.9	1.1	1.0	1.2
Social Studies (MS)	1.6	0.8	1.2	1.1
Foreign Language (All)	0.6	0.6	0.7	0.6
Business (All)	0.9	0.9	0.5	1.1
All Teachers	0.8	0.8	0.9	1.0

Sample: Probability and purposive samples.
*MS = middle school, HS = high school.

The pattern across the first three columns in Table 12 suggests the issues around which meaningful thinking may be most likely to occur in different subjects. For example, in middle school social studies, teachers who report giving their students the task of designing their own "problem to solve" had average scores on the Meaningful Thinking index that were 1.6 standard deviations higher than teachers who did not use that approach. This suggests that meaningfulness in middle school social studies revolves around students choosing topics for their work. In vocational classes, on the other hand, teachers' scores on Meaningful Thinking were particularly high for teachers who reported having students decide on their own procedures. This suggests that meaningful thinking in vocational classes may be centered more around procedural activities.

In summary, within every subject, teachers who report doing more problem-solving also appear to engage students in more meaningful thinking. The combination of problem-solving and meaningful tasks provides a cognitively challenging classroom environment. In the remainder of this report, we employ an index of Cognitive Challenge which combines the information from the 13 survey items concerning meaningful thinking and 3 of the 4 items that asked about problem-solving.[13] Because the Cognitive Challenge Index is central to the rest of this report, we present, in Table 13, the average Cognitive Challenge scores by subject and level. Those scores closely match the data on Meaningful Thinking presented in Table 10, except that the high Problem-Solving scores of middle school math teachers and vocational education teachers raise their average Cognitive Challenge scores closer to the midpoint for all teachers. In contrast, scores of English and social studies teachers are somewhat reduced for this measure of Cognitive Challenge compared to the prior measure. Again, the score for elementary teachers is not strictly

[13] The fourth Problem Solving item, "working in groups to jointly solve a problem," was excluded from the combined Cognitive Challenge index because it was assigned instead to the "Group Work" component of constructivist practice.

comparable to the others because the vast majority of such teachers teach all-day self-contained classes and many of the survey items are affected by the overall extent of teacher contact with the same students.

TABLE 13: FREQUENCY OF COGNITIVE CHALLENGE BY SUBJECT AND LEVEL TAUGHT (INDEX MEAN Z-SCORE)

Ranking by Subject & Level*	Mean Z-Score on Cognitive Challenge Index (16 items)
English (HS)	0.53
Elementary	0.33
English (MS)	0.27
Social Studies (HS)	0.09
Science (MS)	– 0.01
Vocational (All)	– 0.14
Math (MS)	– 0.17
Science (HS)	– 0.25
Social Studies (MS)	– 0.29
Computer (All)	– 0.36
Foreign Language (All)	– 0.45
Math (HS)	– 0.54
Fine Arts (All)	– 0.60
Business (All)	– 0.82
All Teachers	0.01

Sample: Probability sample.
*MS = middle school, HS = high school.

ACTIVE LEARNING STRATEGIES: PROJECTS AND WORK IN SMALL GROUPS

Discussions of reform teaching practices often focus on students working actively on "authentic" projects and often involve both collaborative work groups and a specific end-product developed for a specific audience. However, we have introduced constructivist pedagogy in a completely different way—focusing on instruction that is cognitively challenging as a result of the teacher designing tasks that are personally meaningful to students. The obvious research questions are whether these two aspects of teaching practice—active, collaborative project-based work and cognitively challenging tasks—(a) tend to occur among the same teachers and (b) tend to occur at similar relative frequencies across the various secondary subjects and levels. In other words, are the teachers who frequently have students do project and group work the same teachers who provide cognitively challenging instruction? Are the subjects and levels where we find higher rates of cognitively challenging instruction the same subjects and levels where higher-than-average rates of project and group work activities prevail?

One can easily imagine that many teachers whose classes do projects and group assignments do so for reasons other than a belief in a constructivist learning theory. They may use projects and group work as teaching methods because they find that students *enjoy* those activities more. To the extent that projects and group work strategies are not really being guided by pedagogical beliefs about learning, but instead by simple classroom survivability, the way that teachers use these strategies might differ a great deal and the consequences for student learning may differ as well. For example, teachers who use projects and group work but who do not believe in constructivist theories of learning may follow a procedurally-scripted approach rather than one in which students are being intellectually challenged. Group work assignments may simply involve

students dividing up their work and sharing answers to worksheet problems. Projects may involve little self-direction and require little reflective thought.

Similarly, teachers who provide students with a cognitively challenging educational experience may teach using direct explanations as much or more than other teachers. If so, this would suggest that teaching through projects and collaborative group work may not be important approaches for providing intellectually enriching school experiences.

First, we address the prevalence of group work and its relationship to cognitive challenge. Then project work is discussed in the same way.

Group Work – Prevalence and Relation to Cognitive Challenge

To get a rough estimate of how teachers divide up the time they have for classroom instruction, respondents were asked to estimate, out of the most recent five hours of teaching to their sampled class, the amount of time spent on each of four activities: teacher-led whole-class discussion, student-led discussion or presentations, seatwork assignments, and small group work. Somewhat surprisingly, teachers reported more time spent in group work than in any of the other activities. Based on teacher self-reports regarding the last five hours taught, only computer and business teachers report more seatwork than group work, and only foreign language and math teachers report more whole-class teacher-led instruction than group work. In fact, a majority of all teachers reported that students worked in groups for more than one hour out of the last five. Although in answer to another survey question, more teachers reported that their students did seatwork on a daily basis than reported daily "work in small groups to come up with a joint solution or approach to a problem" (20% vs. 14%), if one were to add in *other purposes* of small group work, the total daily use of group work might easily exceed the number reporting daily seatwork.

Teachers find that older students' have a greater ability to conduct their activities in groups for extended periods of time. Elementary teachers generally report doing less group work than do secondary teachers. More than half (56%) of the secondary academic teachers report more than an hour of group work in the last five, compared to 41% of elementary teachers.

Among secondary teachers, more than two-thirds of science teachers have students work in groups (or pairs), probably in lab settings. It was business teachers who reported the least time having students work in groups (only 29% for more than an hour in the last five, less than any other subject). Interestingly, business teachers were also least likely to spend more than an hour having students give presentations or lead discussions. In fact, only 1% of business teachers report this activity as compared to 21% of vocational teachers. Given the importance of working in teams and making presentations in business settings, this finding is striking.

TABLE 14: FREQUENCY OF GROUP WORK ACTIVITIES BY SUBJECT AND LEVEL TAUGHT

	Specific Group Work Items (percent meeting criterion)			
Subject & Level*	Students worked in groups for more than one hour out of the last five	Small group solutions to problems (weekly or more)	Introduced current unit with small group discussion	Mean Z-score on Group Work Index
Science (MS)	70	48	44	0.26
English (HS)	51	37	49	0.17
Elementary	41	56	41	0.16
Vocational (All)	69	50	44	0.15
Social Studies (HS)	59	38	39	0.02
Math (MS)	57	59	29	0.02
Math (HS)	54	45	29	– 0.05
Science (HS)	66	37	31	– 0.09
English (MS)	41	32	37	– 0.11
Foreign Language (All)	37	39	34	– 0.19
Social Studies (MS)	46	29	36	– 0.24
Computers (All)	55	34	33	– 0.29
Fine Arts (All)	62	21	20	– 0.55
Business (All)	29	25	19	– 0.76
All Teachers	51	44	37	0.00

Sample: Probability sample.
*MS = middle school, HS = high school.

For some academic subjects, differences between middle school and high school level teachers were notable. It seems clear that in science, group work is more prevalent in middle schools while in social studies it is more prevalent at the high school level. (See Table 14.) Not only do high school social studies teachers do more group work, but they also report less seatwork than middle school social studies teachers. (Only 19% reported more than an hour of seatwork compared to 48% of middle school social studies teachers.)

In a second survey question about the frequency of group work (mentioned briefly earlier), teachers were asked about how often they have students work in groups in order to come up with a joint solution or approach to a problem. At the secondary level, 44% of academic teachers reported that they had students work in problem-solving teams on a weekly basis. This activity is most commonly found among math teachers, particularly middle-school math teachers, 59% of which report group problem-solving at least weekly. Science teachers are the next most likely to have students work in this type of group, but this also occurs more often in middle school classes. Most elementary teachers also reported using this teaching strategy, but, as with other frequency measures, it is difficult to compare the answers of the elementary teachers because most of them taught self-contained (whole-day) classes and thus had more time to implement a variety of teaching methods. (See Appendix Table A-5.)

The last question about group work in the TLC survey concerns whether, as a means of introducing a new unit to students, the teacher divided students into small groups to discuss topics related to the new unit. Overall, just over one-third (37%) said they did so on the current lesson being taught. Introducing a unit this way, which is probably more time-consuming than other approaches, tended to happen more at the middle school level and varied by subject. For example, middle school science teachers used group discussions as unit starters more than high school science teachers did. However, in contrast, high school English teachers used groups in this way more often than middle school English teachers did. These school-level differences within subjects parallel what was found for the other group work items in Table 14.

Relationship of Group Work to Cognitive Challenge, by Subject and Level Taught

So far, we have described the extent and variety of group work that occurs in the different subjects. However, a more central question for understanding teacher pedagogy is to learn to what extent small group work is associated with cognitively challenging tasks rather than being reflective of "mere activity." To do this, we compare scores on our Cognitive Challenge Index of teachers who make substantial use of group work (i.e., teachers who are above the 50th percentile for their subject-matter in overall group activity) and Cognitive Challenge scores of teachers in the same subject who use small group strategies less often.

The findings in Table 15 clearly support the idea that teachers whose students do group work are much more oriented towards providing instruction that is cognitively challenging than are teachers who use group work strategies less often, if at all. Across all subjects, the effect size between above-average group-work-using teachers and below-average users on Cognitive Challenge is +0.9, or close to a full standard deviation. Within each subject and school level (every one except secondary foreign language), teachers who use group work more than the typical teacher in that subject average at least 0.7 standard deviations higher on Cognitive Challenge than teachers who are less active in using student groups. (Analogous correlation coefficients to these effect size measures are presented in Appendix Table A-6.)

Among the three specific indicators of group work, the highest effect size was found for the item distinguishing between teachers who had students solve problems in small groups on a weekly basis versus those who used that method less often or not at all (E.S.=+0.9).[14] In fact, for a majority of subject-level categories, it was this activity of group problem-solving that had the highest effect size on Cognitive Challenge. Group problem-solving is particularly associated with high Cognitive Challenge among social studies teachers (both middle and high school), middle school math teachers, and elementary teachers. The effect sizes for all four of those groups was greater than 1.0 standard deviation units.

The strategy of using group discussions as part of unit introductions is also associated with substantially higher Cognitive Challenge. Like the first item discussed, this relationship was true for teachers of every subject and level studied except for foreign language teachers. The use of group discussions to introduce a unit seems particularly likely to be motivated by a constructivist theory of learning, which argues as its central thesis that prior student understandings should be the starting point for instruction. This approach was particularly associated with high Cognitive Challenge in computer classes (E.S. = 1.1).

By comparison, reporting an hour or more of group activity in the last five was somewhat weaker than the other two items in terms of predicting Cognitive Challenge (E.S.=+0.5). In some subjects, (e.g., vocational-education, high school social studies and math, and middle school science), teachers may routinely be able to spend an hour or more having students work in groups, without engaging groups in reflective writing activity, posing probing questions, or having them engage in problem-solving. Even so, for other subject-level combinations—middle school math and high school English, in particular—the teachers who were more likely than average to assign group work to their selected class over the previous five class meetings were also the teachers whose practice involved more cognitively challenging activities.

[14] Although the survey item has explicit "problem-solving" elements in it, the effect size was nearly as strong (E.S.=0.7) when only considering the Meaningful Thinking sub-scale—i.e., excluding the problem-solving items.

TABLE 15: EFFECT SIZE OF GROUP WORK ON COGNITIVE CHALLENGE

Subject & Level**	Cognitive Challenge E.S. by Group Work Practices (criterion met vs. not met): Work in small teams >1 hr in last 5*	Small group solutions to problems weekly	Introduced new unit w/groups this time	Cognitive Challenge E.S. by Group Work Index (Top 50% on index vs. bottom 50%)
Science (MS)	0.2	0.8	0.7	0.8
English (HS)	0.9	1.0	0.3	0.7
Elementary	0.6	1.1	0.7	1.0
Vocational (All)	– 0.1	0.8	0.8	0.7
Social Studies (HS)	0.2	1.1	0.7	0.8
Math (MS)	0.8	1.1	0.7	1.1
Math (HS)	0.3	0.7	0.5	0.9
Science (HS)	0.5	0.8	0.8	1.0
English (MS)	0.4	1.0	0.8	0.9
Foreign Language (All)	*	0.2	0.4	0.2
Social Studies (MS)	0.5	1.1	0.8	0.9
Computer (All)	0.4	0.9	1.1	1.0
Fine Arts (All)	*	0.8	0.9	0.8
Business (All)	*	*	*	1.3
All Teachers	0.5	0.9	0.7	0.9

Sample: Probability and purposive samples. Data in first column are from questionnaire versions 3 and 4 only.
* Too few cases either meeting frequency of use criterion or not meeting criterion for a valid comparison. (Generally, Raw N < 25.)
**MS = middle school, HS = high school.

Student Projects and Hands-on Activities

Student projects constitute a fairly wide range of teacher-directed learning activities. What are called "projects" by different teachers vary in their duration; in the number and types of different tasks involved; in how much variation between students in project content that a teacher permits; and in the degree of independence, creativity, and initiative encouraged. Nevertheless, compared to other common types of classroom assignments, projects tend to be much longer in duration, involve a wider variety of tasks, permit greater variation among students in the work that they do, and provide for greater independence, creativity, and initiative than other school assignments.

Overall, about one-half of the teachers in our study (48%) report that students in their selected class are involved each month in projects of a week or longer in duration. Elementary teachers are more likely to report having their students do projects than are secondary teachers of academic subjects (56% vs. 39%). That difference is likely to be in large part due to the fact that most elementary teachers have the same students in class for many more hours than secondary teachers do. The difference in project use between elementary teachers with self-contained classes and other elementary teachers is nearly as great (60% vs. 47%) as the difference between all elementary teachers and secondary teachers of academic subjects.

Among secondary teachers, projects are a more central part of teaching in the applied subjects than in academic subjects. Projects lasting a week or longer were most common among fine arts and computer teachers (92% and 74%, respectively), but also occurred in a majority of vocational education and business education classes. However, they were also part of the teaching practice of a majority of English teachers, both at the middle school level (60%) and high school level (64%; see Table 16). From a different perspective, given the larger numbers of teachers in academic subjects, it is still the case that more than half of all student project activity in secondary schools takes place in English, science and social studies classes. (See Table A-7.)

TABLE 16: FREQUENCY OF PROJECT ACTIVITY BY SUBJECT AND LEVEL TAUGHT

Subject & Level*	% Week-long Projects Monthly +	% Hands-on or Labs Weekly +	% Creation of Product for Use by Others Monthly +	% Demonstrate for Outside Audience Monthly +	Overall Projects Z-score (all 4)
Fine Arts (All)	92	91	21	28	1.33
Vocational (All)	66	83	53	30	1.11
Computer (All)	74	97	36	15	0.97
Business (All)	59	80	4	18	0.30
Elementary	56	61	12	12	0.16
Science (MS)	38	70	14	9	0.09
English (HS)	64	33	9	16	–0.06
English (MS)	60	33	8	10	– 0.14
Science (HS)	39	65	4	5	– 0.14
Foreign Language (All)	27	29	29	11	– 0.21
Social Studies (MS)	48	34	9	10	– 0.23
Social Studies (HS)	39	27	5	10	– 0.34
Mathematics (MS)	13	24	9	6	– 0.68
Mathematics (HS)	7	18	2	1	– 0.92
All Teachers	48	51	12	11	0.00

Sample: Probability sample.
*MS = middle school, HS = high school.

Another survey question asked teachers about an instructional practice similar in many ways to weeklong projects: the use of "hands-on or laboratory" activities. Like projects, hands-on work is meant to give students an opportunity to apply ideas in concrete ways—to make use of knowledge rather than treat it as a set of abstract concepts. Like week-long projects, hands-on work is very common in applied secondary courses (80 to 97% reporting weekly hands-on activity), but are nearly as frequent in science classes (65-70% weekly). However, the concept of "hands-on" may not have wide understanding in other academic subjects, since at most one one-third of the teachers of other academic subjects (social studies, math, English, and foreign languages) reported giving students even monthly opportunities to engage in hands-on work.

The one notable difference between middle and high school teachers concerns social studies teachers. Social studies teachers in middle school spend more class time on student project-type activity, both the weeklong projects we asked about in one question and the "hands-on" work from the other question.

In addition to week-long projects and hands-on activity, we also asked about more ambitious, and consequently less common, types of projects—ones that involve students making a product for use by others and ones in which they demonstrate their work to audiences other than their own school or family. Only about 10% of all teachers reported having their selected class do these activities to any extent. (See Table 17.)

TABLE 17: PERCENT OF TEACHERS REPORTING DIFFERENT TYPES OF PROJECT ACTIVITIES

	How often do students...			
Project Activities Overall Reported...	Work on projects that take a week or more	Do hands-on/ laboratory activities	Create a product for use by someone else	Demonstrate their work to audience beyond school/ home
Never	10	8	46	53
Sometimes	42	20	41	35
1-3 times per month	28	21	9	9
1-3 times per week	8	32	3	2
Almost everyday	11	19	0	0
Total	100	100	100	100

Sample: Probability sample.

As with project work in general, it is clearly the case that applied teachers more often have students create products for use by others or demonstrate their work to an outside audience. Vocational teachers employ these approaches most often, with more than 50% saying their students produced a product for use on a monthly basis and 30% saying their students demonstrated their work before an outside audience. Next to vocational education teachers, products made for use were most often part of computer teachers' practices (36%, monthly), while demonstrations of work to outsiders were most commonly done by students in fine arts classes (28%, monthly). In contrast, fewer than 10% of the secondary academic subject-matter teachers said their students produced products for use (monthly) and only slightly more said their students demonstrated their work before outside audiences. Among the academic teachers, demonstrations were most common among high school English teachers, but even there, only one in seven reported this as part of their practice (14%).

In sum, a far greater proportion of teachers in the applied subjects have students doing project work than in academic classes. The one exception is in English, where most students are asked to work on projects that take a week or longer; and in science, where most teachers have students do laboratory and other hands-on work on a weekly basis. Overall, more project-based activities occur in middle school academic classrooms than in high school academic classrooms. We suspect that high school academic teachers may have more curriculum pressures and lack the curricular flexibility of middle school teachers.

Project Activity and Cognitive Challenge:

All four aspects of project work measured are moderately to highly associated with higher levels of cognitive challenge. Overall, the largest effect size is for students creating products for use by others (E.S.=0.7).[15] However, the other three items' effect sizes were all between 0.5 and 0.6.

The relationship between project use and cognitive challenge varies a great deal by subject. Business education teachers who are above the median in project use have only slightly higher scores on cognitive challenge than other business education teachers, suggesting that projects are not particularly a vehicle for raising the intellectual level of subject-matter content in business courses. On the other hand, among English, science, middle school math, and elementary teachers, those who do more projects are close to if not a full standard deviation higher on use of cognitively challenging strategies than teachers in the same subjects who are less active in the use of student projects.[16] In these subjects, projects indeed may be an important mechanism whereby cognitively-oriented teachers enable students to have a more meaningful learning experience.

The cognitive challenge of particular types of project activities (e.g., demonstrations, making useful products, etc.) appears to vary subject-by-subject. Foreign language teachers' use of language labs and high school math teachers' use of hands-on activities seems not to be related to cognitive challenge whereas for other academic subjects and even for middle school math, the teachers who give students projects and hands-on activities to work on do report greater use of cognitively challenging teaching strategies. (See Table 18.)

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[15] This analysis contrasts teachers who report that product-for-use and demonstration-to-outsider activities were part of their teaching practice at all versus teachers who did not do these things. The earlier descriptive analysis dichotomized these variables at "monthly or more" versus less often or not at all. However, because even monthly frequency is so rare, dichotomizing at "monthly or more" would have produced too few cases for most subjects to permit calculation of reliable effect sizes.

[16] Correlation coefficients in Appendix Table A-6 produce essentially the same results.

TABLE 18: EFFECT SIZE OF PROJECT ACTIVITY ON COGNITIVE CHALLENGE

Subject & Level**	Cognitive Challenge E.S. by Project Practice (criterion met. vs. not met): Week long projects monthly +	Hands-on/Labs weekly +	Make product for use by others sometimes +	Demonstrate work to an audience sometimes +	Cognitive Challenge E.S. by Project Index (top 50% on index vs. bottom 50%)
Fine Arts (All)	*	*	1.3	*	0.8
Vocational (All)	0.9	*	*	0.9	0.8
Computer (All)	0.4	*	0.7	0.9	0.6
Business (All)	0.2	*	0.4	0.6	0.1
Elementary	0.9	0.7	0.7	0.6	0.9
Science (MS)	0.6	0.8	0.8	0.4	0.8
English (HS)	0.6	0.6	0.9	0.9	0.9
English (MS)	0.7	0.7	0.7	0.7	0.9
Science (HS)	0.8	0.6	0.5	0.7	0.9
Foreign Language (All)	0.5	– 0.1	0.3	0.8	0.4
Social Studies (MS)	0.6	0.7	0.8	0.6	0.7
Social Studies (HS)	0.7	0.8	0.5	0.3	0.6
Math (MS)	0.4	0.7	0.8	0.8	0.8
Math (HS)	0.6	0.1	0.6	0.5	0.5
Total	0.6	0.5	0.7	0.6	0.8

Sample: Probability and purposive samples.
* Too few cases either meeting frequency of use criterion or not meeting criterion for a valid comparison. (Generally, Raw N < 25.)
** MS = middle school, HS = high school.

Comparing and Combining Projects and Group Work:

We examined the co-incidence of projects, group work, and activities involving cognitive challenge and found that, indeed, within every subject, the teachers who are most actively engaged in both project and group work in their classes provide substantially more activities associated with cognitive challenge than other teachers do. For example, compared to the average high school English teacher, teachers who are above-average in both the use of projects and group work have average z-scores that put them into the 82nd percentile (among high school English teachers) on assigning cognitive challenging tasks to their students. Similar results were found for every academic subject and for computer education teachers as well. In contrast, teachers who are below-average on use of both projects and group work also are far below average on assigning cognitively challenging tasks. (See Table 19.)

The effect sizes of both group work and projects on cognitive challenge are substantial (0.9 and 0.8, respectively). For most subjects, projects and group work are about equally associated with cognitive challenge. However, for mathematics, computer classes, and high school social studies, group work is more associated with high cognitive challenge than project work is. In those subjects, projects may be fairly superficial while group work may form the basis of serious discourse about understanding the content of the subject.[17]

Overall, it is the presence of above-average frequency of *both* projects and group work that most strongly predicts whether a teacher provides high cognitive challenge, according to our measure.

[17] One distinction comes from the exploratory factor analyses. While project activities consistently loaded on a separate factor, group work items often loaded with other items linked with cognitive challenge.

Generally, the effects of the two components are additive—a teacher who is above-average on either projects or group work employs cognitively challenging tasks more than one who is below-average. The large correlations among these three components of constructivist pedagogy, among teachers of the same subject area, suggests that teachers who view learning as a meaning-constructing process will generally be the same teachers who prioritize conceptual understanding over factual learning and routine skill competencies and will tend to incorporate all three pedagogical practices into their teaching—student projects, students working in groups, and tasks that provide cognitive challenge.

TABLE 19: WITHIN-SUBJECT COGNITIVE CHALLENGE SCORES, BY TEACHERS SCORING ABOVE OR BELOW THE MEAN OF SAME-SUBJECT TEACHERS ON PROJECTS AND GROUP WORK

	Above mean in either projects or group work				
Subject & Level*	Neither	Projects only	Group work only	Both	Total
English (M)	-.76	-.12	-.10	.62	-.09
English (H)	-.66	.13	.03	.90	.10
Social Studies (M)	-.51	-.35	-.22	.54	-.09
Social Studies (H)	-.51	-.02	.27	.62	.12
Science (M)	-.44	.18	.13	.84	.26
Science (H)	-.68	-.19	-.07	.73	-.17
Math (M)	-.61	-.03	.30	.94	.20
Math (H)	-.68	-.22	.16	.53	-.20
Computer (All)	-.68	-.20	.18	.81	.00
Elementary	-.75	-.02	.01	.72	.00
All Teachers	-.64	-.07	.08	.71	.00

Sample: Probability and purposive samples.
*MS = middle school, HS = high school.

TRADITIONAL INSTRUCTION: PREVALENCE AND COGNITIVE CHALLENGE

The final set of survey items dealing with teacher pedagogy that we examined are a set of measures of fairly common teaching practices that are generally associated with a skills-practice and knowledge-transmission orientation rather than with constructivist pedagogical beliefs and practices. These include frequency of teacher-led whole-class discussions, individual seatwork ("answering questions in the textbook or worksheets"), asking questions in order to test students' knowledge of the correct answer, and having students do introductory drills to introduce them to a new unit.

Do these traditional activities represent an independent aspect of a teacher's overall repertoire, one that most teachers can be expected to follow regardless of how much they use projects and group work or whether or not they emphasize cognitively challenging strategies? Or do they represent an alternative view of instruction that occurs mainly among teachers who do not employ the constructivist-compatible practices that we have already discussed?

We briefly present the prevalence of the specific skills- and transmission-oriented practices in our survey, and then show the relationship between these practices and the use of projects, group work, and cognitive challenge, both between subjects and within subjects.

Of the transmission-oriented activities we asked about, one very common practice involves the use of textbooks and worksheets. Two-thirds of all teachers report assigning worksheets or textbook exercises to students in their selected class. Nearly as many (64%) often introduce a

new unit to students by having them do introductory drills on related skills or facts. A majority of teachers "very often" or "always" ask students questions in order to check that students know the "correct" answer. And most teachers spend some time in whole-class discussion mode, asking students a series of inter-related questions, though only one third did so for more than one hour in the last five. Table 20 shows the percentage of teachers by subject and level who reported using these practices frequently. However, the z-score index in the last column of the table is based on how *infrequently* these practices are used; thus it represents "infrequent use of traditional practices."

TABLE 20: USE OF TRADITIONAL PRACTICES BY SUBJECT AND LEVEL TAUGHT (PERCENT)

Subject & Level*	More than one hour of teacher-led recitation in the past five hours	Ask questions to check for correct answer very often or more	Often use drills to introduce a unit or did so for the current unit	Have students answer questions from text or worksheet monthly +	Mean Z-score on Index (reversed)
English (HS)	25	30	49	49	0.68
Fine Arts (All)	16	48	77	21	0.66
Vocational (All)	13	43	62	62	0.32
Computer (All)	4	54	87	39	0.31
Science (MS)	31	48	61	65	0.24
English (MS)	23	52	59	66	0.19
Social Studies (MS)	43	53	62	57	0.11
Science (HS)	43	48	60	72	0.09
Social Studies (HS)	41	52	64	62	0.06
Elementary	29	54	59	79	– 0.11
Business (All)	9	71	87	67	– 0.26
Math (MS)	64	68	76	84	– 0.55
Foreign Language (All)	43	77	86	80	– 0.58
Math (HS)	69	64	79	88	– 0.70
All Teachers	33	54	64	68	0.00

Sample: Probability sample.
**MS = middle school, HS = high school.

The classes where these transmission-oriented practices are *least frequent* are high school English, computer classes, vocational education, fine arts, and middle school science. Interestingly, all five of those classes have the *highest* mean scores on one of the components of constructivist practice already discussed: High school English classes are highest on cognitive challenge; fine arts, vocational education, and computer classes have the three highest mean scores on projects; and middle school science teachers use group work more than any other category of teacher. In contrast, the subjects where knowledge-transmission- and skills-oriented practices are *most* common are the same subjects where the previously identified components of constructivist practice are *least common*—mathematics (lowest in the use of projects), business education (lowest in both cognitive challenge and group work), and foreign language (among the lowest in cognitive challenge and low on projects as well). (See Table 21, which shows the rank-order of each of 15 groups of teachers on all of the measures of constructivist teaching practice, including "infrequent use of traditional practices" which we are discussing here.)[18]

These findings strongly suggest that how frequently teachers of a given subject use skills-practice and transmission activities is inversely related to how frequently teachers of that subject follow a constructivist teaching practice.[19]

[18] For the actual mean z-scores on each of the constructivist practice components for each subject and level combination shown in Table 21, see Table A-8.

[19] We do not want to deny the value of traditional methods for producing learning under the right circumstances, for example when time is short and specific skills are desired. The question is more the

TABLE 21: RANKING OF SUBJECTS/LEVELS
BY EACH COMPONENT OF CONSTRUCTIVIST TEACHING PRACTICE

	Constructivist Practice							
	Cognitive Challenge			Active Learning				(Constr-uctivist Practice Index)
Subject & Level*	Meaningful Thinking	Problem-Solving	(Cognitive Challenge Index)	Group Work	Projects	Infrequent traditional practices	(Active Learning Index)	
English (MS)	2	11	3	10	9	6	8	4
English (HS)	1	8	1	3	8	1	4	1
Social Studies (MS)	7	13	10	12	12	7	12	11
Social Studies (HS)	4	10	5	6	13	9	10	8
Science (MS)	6	4	6	1	6	5	5	5
Science (HS)	9	9	9	9	10	8	9	10
Math (MS)	11	1	8	7	14	13	14	12
Math (HS)	14	6	13	8	15	15	15	15
Foreign Lang. (All)	10	14	12	11	11	14	13	13
Computer (All)	12	7	11	13	3	4	3	7
Business (All)	15	15	15	15	4	12	11	14
Vocational (All)	8	3	7	4	2	3	2	3
Fine Arts (All)	13	12	14	14	1	2	1	9
Elementary Self-contained	3	2	2	2	5	11	6	2
Elementary Other	5	5	4	5	7	10	7	6

Sample: Probability sample.
*MS =middle school, HS = high school.

The previous conclusion concerned comparisons of teachers in different subjects—i.e., subjects whose teachers reported infrequent use of traditional practices were the same subjects where teachers reported frequent use of cognitively challenging practices. However, the question remains about the pattern *within* each subject: In any given subject, are the teachers who most *infrequently* use transmission and skills-practice activities the same teachers who most *frequently* employ practices that emphasize cognitive challenge? (And vice versa—do the heavily traditional teachers score *lowest* on Cognitive Challenge?)[20]

quality of the learning that is taking place, and the meaningfulness of the goals. When they are developed and used effectively, there are instructional methods that are consistent with so-called "traditional teaching" that could engender deep thinking in students under specific circumstances, for example an inspirational lecture before an activity where important issues are raised. Are we saying a teacher should never lead the whole class in a discussion? No, just that the amount of time spent on that does take away from other activities. Judicious use of traditional methods may be entirely appropriate at times. Clearly, this survey emphasized constructivist-compatible practices and did not attempt to measure the *quality* of so-called traditional instruction as carefully as it did the many faces of constructivist teaching. It is possible that if we had asked enough questions, we would have found traditional-compatible practices that could promote deep thinking, or that would impact some other measures.

[20] The same question can be asked about the relationship between infrequent use of traditional practices and frequency of use of projects and of group work. The correlations among the three components of what we call "Active Learning Strategies" are shown in Appendix A-4, separately for each subject-level combination. Correlations between infrequent traditional practices and use of projects are quite high, averaging nearly 0.4 for the 15 categories of teachers examined, nearly the identical average as found for the correlation between projects and group work. However, the correlations between infrequent use of traditional practices and group work are substantially smaller, averaging only 0.13 for the same categories of teachers.

The answer is that academic teachers who reported the *least* frequent use of traditional transmission and skills-practice activities scored *somewhat* higher on the Cognitive Challenge Index (and vice versa). However, the pattern is not uniform across all academic subjects nor is it true for the applied secondary subjects. The strongest patterns (with effect sizes of 0.5 or higher) are for foreign language teachers, middle school math and English teachers, and high school English teachers. In those subjects, the teachers who frequently use transmission and skills-practice activities are the least likely to have high Cognitive Challenge scores. However, in other academic subjects—science, high school social studies, and high school math—the relationships, although positive, are smaller.[21] In other words, it may be more possible for direct instruction approaches and cognitive challenge to co-exist in those particular subjects and levels. And in the applied subjects, there is either no relationship (as among fine arts, vocational education, and computer teachers) or even the opposite one (among business teachers). That is, for business education teachers, those who most frequently report using traditional skills-practice activities also are the ones who most frequently report using cognitively challenging ones (see Table 22).[22]

[21] In this case, a few of the correlation coefficients produce somewhat different results. In particular, the correlation for middle school math teachers is not as high as the effect size would indicate (r=0.2). See Appendix Table A-6.

[22] The smaller association between *infrequent* use of transmission practices and *frequent* use of cognitively challenging ones (compared to the associations reported among other pairs of components) is at least partly due to the effects of questionnaire response style on measured effect sizes. Here we are finding small positive asssociations between low frequency of one type of practice and high frequency of another type of practice, whereas the other findings (high positive associations) are between high frequency of two types of practices. Thus, whereas in the other findings response style patterns resulted in measured associations that are probably higher than are true, in fact, in this case the response style effects work to diminish the size of the association. Consequently, to the extent that response style patterns are operating, the true effect sizes between infrequent traditional practices and Cognitive Challenge are larger (more positive) than the measured effect sizes.

TABLE 22: EFFECT SIZE OF THE AVOIDANCE (INFREQUENCY) OF TRADITIONAL PRACTICES ON COGNITIVE CHALLENGE

Subject & Level**	Cognitive Challenge E.S. by ***Infrequency*** of Traditional Practices (criterion met vs. not met)				Cognitive Challenge E.S. by Traditional Practices Index (***bottom*** 50% on index vs. top 50%)
	One hour or ***less*** of whole class discussion	***Not*** testing student knowledge of "correct answers" very often	Did ***not*** or rarely use introductory drills	Individual work in textbooks or worksheets ***less*** than monthly	
English (HS)	0.5	0.2	0.6	0.4	0.5
Fine Arts (All)	*	0.2	0.1	– 0.1	0.1
Vocational (All)	*	0.0	0.2	– 0.1	0.1
Computer (All)	*	0.2	– 0.4	– 0.2	– 0.2
Science (MS)	*	0.1	0.0	0.4	0.3
English (MS)	0.2	0.6	0.3	0.6	0.6
Social Studies (MS)	0.2	0.3	0.0	0.4	0.4
Science (HS)	0.6	0.2	– 0.1	0.2	0.2
Social Studies (HS)	0.2	0.1	0.5	0.2	0.2
Elementary	0.3	0.4	0.3	0.5	0.4
Business (All)	*	– 0.3	*	– 0.7	– 0.5
Math (MS)	0.2	0.3	0.1	0.0	0.6
Foreign Language (All)	*	0.5	*	0.3	0.7
Math (HS)	0.3	0.0	– 0.3	0.1	– 0.1
All Teachers	0.3	0.2	0.1	0.2	0.3

Sample: Probability and purposive samples. Data in first column are from questionnaire versions 3 and 4 only.
* Too few cases either meeting frequency of use criterion or not meeting criterion for a valid comparison. (Generally, Raw N < 25.)
**MS = middle school, HS = high school.

PART III. THE RELATIONSHIP BETWEEN TEACHER BELIEFS AND PRACTICES

In this report, we have presented information about how a national sample of teachers across every major subject and school level (in grades 4-12) responded to survey questions regarding their beliefs about good teaching and their instructional practices in one particular class. For the most part, we presented descriptive findings about individual survey items, broken down by subject and level, although in addition, items were aggregated into seven indices based on a series of exploratory factor analyses.[23] An argument was presented suggesting that these indices represent distinct, yet correlated, aspects of an underlying global dimension of pedagogy that ranges from a primary reliance on and belief in an information transmission and skills-practice model of pedagogy to a belief in and use of instructional practices more compatible with a constructivist theory of learning. We presented evidence that a strong relationship exists between the component of instructional practice labeled Cognitive Challenge and other aspects of a constructivist teaching practice—use of projects, group work, and (to a lesser extent) a relatively infrequent reliance on traditional transmission and skills-practice strategies. To complete our understanding of this aspect of teacher pedagogy, we need to understand the relationship between teachers' beliefs about good teaching and their actual use of various practices in the classroom.

How teachers organize classroom activities is a function of many influences—external pressures to cover curriculum or to prepare students for examinations, the expectations of a teacher's colleagues and immediate supervisors, the skills and confidence a teacher has that different instructional approaches can be managed in a diverse classroom with space, resource, and scheduling limitations, and many other factors. However, teachers are also likely to feel accomplished when they can implement classroom practices that are consistent with what they regard as good and important teaching—when they can teach students about content that they themselves believe is important for students to know and when they can provide a collective learning experience that they think is likely to result in students growing and maturing in various ways, both intellectually and socially.

To what extent do teachers' actual classroom practices reflect their strongest beliefs about good teaching? Are teachers' practices constrained greatly by external pressures or by a "realistic" understanding about what kinds of instruction can successfully be employed in the particular classroom settings in which they teach? By asking teachers to answer questions both about their teaching philosophy and about how they teach in the specific class "where you are most satisfied with your teaching—where you accomplish your teaching goals most often," we hoped to get a rough handle on the extent of this relationship.

There are two questions involved. One is the absolute level to which a teacher implements her philosophy in practice. The other is the extent to which philosophy and practice are correlated across teachers—that is, "How much more likely are teachers with a more constructivist philosophy to teach in a more constructivist way?" Both of these questions are addressed here.

One approach to looking at these issues might be to compare individual survey questions about beliefs with "parallel" questions dealing with classroom practice. Although the belief and practice

[23] As indicated earlier, factor analyses were used to decide which items to group together, but indices combining items were constructed by taking mean values of items, after standardizing each item to have similar variance.

questions were not designed with parallelism in mind, there are some pairs of items that deal with similar issues.

One "beliefs" question, for example, asked teachers whether they agreed that instruction should be built "around problems with clear, correct answers, and around ideas that most students can grasp quickly." The "practice" question related to this asked teachers how often their objective for asking questions of students was to find out if students knew the correct answer — a practice that a teacher agreeing with the belief statement would presumably employ. (See Table 23.)

TABLE 23: FREQUENCY WITH WHICH TEACHERS ASK STUDENTS QUESTIONS IN ORDER TO SEE IF THEY KNOW THE CORRECT ANSWER AMONG TEACHERS WITH VARYING BELIEFS ABOUT INSTRUCTION

Belief: "Instruction should be built around problems with clear, correct answers, and around ideas that students can grasp quickly."	Percent asking questions to try to see if students know the correct answer... Never or Sometimes	Often	Very Often or Always	Total
Strongly agree	7	19	74	100
Moderately agree	8	22	71	100
Slightly agree	14	30	56	100
Slightly disagree	14	33	53	100
Moderately disagree	23	30	47	100
Strongly disagree	34	31	36	100
All Teachers	18	29	53	100

Sample: Probability and purposive samples; questionnaire versions 1, 2, and 4.

Though virtually all teachers, beliefs aside, report asking questions to see if students know the correct answer, those who tend to disagree with such an approach are less likely to do so. In fact, only 36% of those who *strongly disagree* with the approach say they are testing students' knowledge "very often" or "always" compared to 74% of those who believe in such a basis for instruction (those who strongly agree with the traditional statement).

We examined another "belief" question that asked teachers to position their own philosophy between two competing approaches to instruction; one that poses the teacher as a facilitator of student learning who provides opportunities and resources for students to discover or construct knowledge for themselves; and the other that describes the teacher's role as one who explains knowledge in a structured manner. This belief item was matched to a practice item that asked teachers how much time they had spent in the last five hours leading a whole-class discussion where students listened and answered questions. Presumably, those who believe in a regimented approach to teaching would allocate more class time to teacher-led discussion. In fact, we found that nearly one quarter of teachers whose philosophy is closer to that of an "explainer" reported more than two hours of teacher-led whole-class discussion in the last five hours while only 6% of those favoring the role of "facilitator" reported that teacher-led discussion had occurred for such a long period of time. (See Table 24.)

TABLE 24: AMOUNT OF TIME SPENT ON TEACHER-LED WHOLE-CLASS DISCUSSION AMONG TEACHERS WITH VARYING BELIEFS ABOUT INSTRUCTION

	Percent of teachers leading a whole-class discussion for...				
Belief:	Under 30 minutes	30-60 minutes	1-1/4 to 2 hours	Over 2 hours	Total
Favors Facilitator	43	37	13	6	100
Neutral	28	40	23	8	100
Favors Explainer	23	25	29	24	100
All Teachers	32	34	21	13	100

Sample: Probability and purposive samples; questionnaire versions 3 and 4.

We examined yet another pair of items, this time addressing student involvement in planning classroom activities. The "belief" item asked teachers whether they agreed or disagreed with the statement that "it is better when the teacher— not the students — decides what activities are to be done." We paired this belief item with one that asked teachers to report how often their students actually suggested or helped to plan classroom activities. As expected, teachers' beliefs manifest themselves in actual practice.

TABLE 25: FREQUENCY WITH WHICH TEACHERS HAVE STUDENTS SUGGEST OR HELP PLAN CLASSROOM ACTIVITY BY WHETHER OR NOT THEY AGREE WITH THE PRACTICE

Belief: "It is better when the teacher — not the students — decide what activities are to be done."	Percent who have students help plan classroom activities...		
	Never or sometimes	Monthly +	Total
Agree	84	16	100
Disagree	66	34	100
All Teachers	76	25	100

Sample: Probability and purposive samples; questionnaire versions 1, 3 and 4.

Table 25 shows that more than one third of those who believe that it is a good idea to consider student input (those who tend to disagree with the traditional statement) actually have students help plan classroom activities at least monthly. This makes them twice as likely to involve students as those who don't believe in the practice (34% vs. 16%). Thus we can show that teachers holding certain constructivist philosophies carry that philosophy into their classroom teaching.

In our second analysis of this issue, a set of 10 different constructivist-related instructional practices were compared with three teacher belief items that clearly contrast between a constructivist and a transmission pedagogy:

- Whether students learned more knowledge from the inquiry-oriented approach to handling class discussion attributed to "Mr. Jones" or from "Ms. Hill's" direct-instruction approach (see above, Figure 1).
- Whether the teacher believed more in being a facilitator for student discovery or in direct instruction ("my job is to explain, to show students how to do the work, and to assign specific practice"; see Figure 2).
- Whether the teacher believed it was better to "have all sorts of activities going on in the classroom" (at the same time) or whether classes were better organized around whole-class assignments with clear directions and accomplishable over short time intervals (also in Figure 2).

Teachers taking opposite positions on these issues were compared in terms of the proportion of them who reported having their selected class engage in each of 10 different activities on at least a monthly basis—activities such as engaging in week-long projects, keeping journals, suggesting

or planning classroom activities, and designing their own problems to solve. Teachers favoring an inquiry approach, being a facilitator, and organizing class time around multiple simultaneous small-group activities were more likely to report doing week-long projects, student journals, designing assignments where students had to "represent the same idea in more than one way," hands-on activities, reflective student essays, and, in fact, nearly every one of the practice items shown in the table. Overall, those who selected the constructivist belief alternative on each survey question were about one-half a standard deviation higher on an index measuring the sum of the number of constructivist activities engaged in (monthly) than teachers who chose the traditional transmission belief statement (or who selected the middle response). (See Table 26.)

TABLE 26: PERCENT OF TEACHERS USING PARTICULAR CONSTRUCTIVIST STRATEGIES (MONTHLY+) BY SPECIFIC BELIEFS ABOUT GOOD INSTRUCTION

		Monthly Activities									
Teacher Beliefs	Number Monthly*	Week-Long Projects	Journals	Multiple Representations	Hands-on/Labs	Students make plans	Essays	Students design problems	Complex tasks with no correct answers	Debate point of view other than their own	Product for extended use
From Figure 1											
Students learn more knowledge from "Jones"											
yes	4.36	57	44	52	79	30	58	29	28	16	14
No**	3.30	39	28	39	67	19	48	19	20	10	12
Difference	+1.06 (E.S.=.47)										
From Figure 2											
Teacher's role should be...											
Facilitator	4.36	60	47	53	77	39	61	30	32	19	15
Explainer**	2.94	38	30	38	66	17	46	15	18	9	8
Difference	+1.42 (E.S.=.63)										
Best classroom activity structure...											
Diverse project activities	4.18	57	47	51	78	34	59	27	29	14	15
Short, whole-class activities**	2.89	37	28	37	64	18	46	15	19	12	7
Difference	+1.29 (E.S.=.57)										

* This column is the mean number of activities undertaken. It includes one other "practice" item besides those shown here—whether the teacher's class spent more than one hour in the past five class hours in small group work.

** Teachers giving the middle, or ambivalent, choice were included here.

Indeed, when we examine the full 13-item Belief Index (see above, page 13), teachers who reported using five or more of the practices in Table 26 were a full standard-deviation higher on the Belief Index (mean = +0.48) than teachers who reported using at most one of the practices (mean = –0.52).

The analysis of the relationship between teacher beliefs and practices has so far collapsed all teachers, regardless of subject or level. However, we have already seen that subject and level play a large role in the relevance of certain instructional strategies to a teacher's practice (and, presumably, in the relevance of related beliefs). For our final foray into this subject, we examined the correlation coefficients between the Belief Index and the various components of constructivist practice, separately for 15 groups of teachers defined by subject and school level.

The correlational patterns show, for most of the 15 subject/level groups, a substantial relationship between teacher beliefs and practices at the level of generality of these indices. As shown in Table 27, the Belief Index correlates at or above r=0.40 with Cognitive Challenge for English, social studies, math, and fine arts teachers at both middle and high school levels, for elementary teachers of self-contained classes, and for middle school science teachers. (High school science teachers fall just below that criterion, at r=0.37.) The correlations between contructivist beliefs and group work are slightly higher (a majority of correlations are at or above r=0.44). The project work correlations are lower than the other two (the median correlation is r=0.32); however, the projects index is correlated above 0.40 with Beliefs for math teachers, elementary teachers, and middle school social studies teachers. Even correlations with "infrequent traditional practices" (i.e., the reverse-scored index of transmission- and skill-oriented practices) tend to be in the +0.30 to +0.50 range (with a median correlation of r=0.38 for the 15 teacher groups). Combining constructivist practice indices together produces slightly larger correlations. The median correlation between "Active Learning" (combining projects, group work, and absence of traditional practices) is 0.48, and when that is combined with Cognitive Challenge for a Combined Constructivist Pedagogy Index, the median rises to 0.49.

TABLE 27: CORRELATION OF CONSTRUCTIVIST BELIEF INDEX WITH COMPONENTS OF CONSTRUCTIVST PRACTICE

		Active Learning Strategies (sub-components)				
	Cognitive Challenge	Projects	Group Work	Infrequent Traditional Practices	Active Learning (total)	Combined Constructivist Pedagogy Index
English (MS)	.43	.29	.42	.49	.43	.47
English (HS)	.48	.38	.51	.49	.57	.58
Social Studies (MS)	.48	.62	.59	.54	.72	.65
Social Studies (HS)	.44	.27	.40	.43	.48	.51
Science (MS)	.40	.32	.44	.46	.51	.49
Science (HS)	.37	.41	.41	.22	.48	.46
Math (MS)	.40	.47	.47	.37	.56	.51
Math (HS)	.45	.46	.44	.34	.58	.58
Foreign Language (All)	.12	.24	.44	.38	.48	.31
Computer (All)	.27	.24	.41	.24	.42	.37
Business (All)	.34	.30	.18	.15	.36	.41
Vocational (All)	.14	.32	.53	– .20	.43	.29
Fine Arts (All)	.48	.14	.11	.28	.23	.45
Elementary Self-contained	.51	.46	.44	.48	.58	.58
Elementary Other	.34	.47	.50	.41	.57	.49
Median correlation in column	.40	.32	.44	.38	.48	.49

Sample: Probability and purposive samples.
MS = middle school, HS = high school.

For some applied secondary school subjects, the Belief Index does not correlate well with some of the constructivist teaching practice indices. Among vocational education teachers, constructivist beliefs are not correlated with cognitive challenge and they tend to be correlated with *frequent* rather than infrequent use of transmission and skills-oriented practices. At the same time, constructivist beliefs correlate well with group work (r=0.53) and fairly well with projects (r=0.32). For business education teachers, constructivist beliefs correlate with the overall Combined Constructivist Pedagogy Index very well (r=0.41); however, the two coefficients between beliefs and (a) group work and (b) traditional practices are both low. Similarly, for fine arts teachers, constructivist beliefs correlate highly with the overall index (r=0.45), but they have weak correlations with both projects and group work.

However, among teachers in every academic subject, the patterns are very consistent: Teachers in that subject who hold more constructivist beliefs than others of the same subject and school level report substantially higher levels of use of all types of constructivist teaching strategies—from cognitively challenging ones to projects and group work and they also report less frequent uses of traditional instructional practices. For academic subject teachers, the correlations between the Belief Index and the Combined Constructivist Pedagogy Index range as high as 0.65 for middle school social studies teachers and go no lower than 0.31 (for foreign language teachers).

These data show that teacher beliefs do a reasonably good job of predicting patterns of practice. Although it would be a mistake to assume that teachers who do not employ a give practice fail to employ it because they lack a belief in its value, the relationships shown do suggest that teachers are more likely to engage in constructivist practices if they state a belief in their validity. In other words, beliefs do help determine practice, and therefore to increase the frequency of constructivist practice, one might need to directly address teachers' philosophies. On the other hand, if one can encourage and guide teachers to carry out a specific practice (even in the absence

of supporting belief), this may change their beliefs about what is desirable and what is feasible in their teaching practice, thus helping to make other constructivist practices more likely. A future report will address changes teachers reported having made over the last three years in their teaching practices and the circumstances under which increased constructivist practice is more likely to occur.

OTHER ANALYSES OF TEACHER PEDAGOGY USING THE TLC DATA

The largely descriptive findings presented in this report is one element in our use of the TLC survey data to analyze teacher pedagogy and its relationship to other aspects of teaching. Analyses are being conducted in two directions: (1) examination of possible determinants of differences in teachers' pedagogy; and (2) examination of possible outcomes of a constructivist teacher pedagogy.

Determinants of Teacher Pedagogy

In terms of possible determinants, we are looking at three types of variables that may influence pedagogy:

- teacher background and role orientation (private practice versus collaborative professional practice),
- student ability and socio-economic background, and
- school professional culture, including aspects of staff development, cohesion, and school-level leadership.

Teacher Background and Role Orientation

Pedagogical differences by teacher gender, years of teaching experience, and educational background have important implications for educational policy. The differences in pedagogy are particularly strong by gender and by educational background, and these will be examined in a future report. The relationship between having a "private-practice" orientation towards teaching and a transmission-oriented pedagogy (or between having a "professional" orientation and a constructivist pedagogy) has been explored in two TLC Special Reports (Becker and Riel, 1999; Riel and Becker, 2000). In particular, a private-practice orientation is likely to make a teacher less responsive to influences of and changes within the larger teaching culture, which despite external pressures towards accountability, is strongly oriented towards a constructivist practice. Teacher leaders who are involved with their peers at school and throughout the profession are among the most constructivist teachers in the country.

Student Background

It seems reasonable to believe that teachers feel that students of apparent higher ability or greater prior knowledge respond more favorably to one type of teaching approach as opposed to another, or that teaching in low socio-economic-status communities brings greater pressures for teachers to adopt transmission-oriented practices. A future report will examine equity issues in technology use and pedagogy.

School Culture

Teacher pedagogy may be affected by the cultural environment in which they work—for example, staff development opportunities, cohesion and goal uniformity among the teaching staff and between administrators and teachers, the extent of external pressure to teach at variance with

one's beliefs, the attitudes of school administrative leaders, and the pedagogy of teachers with whom they work. The relationship of many of these variables to teacher pedagogy have already been examined in the Becker and Riel (1999) paper. Future work will incorporate more of these in greater depth.

Outcomes of Teacher Pedagogy

The principal focus of the Teaching, Learning, and Computing study is on the determinants of teachers' use of information and communications technologies. In Report 1 of this series (Becker, 1999) we already showed that teacher pedagogy is a principal variable for identifying which teachers use the Internet, both professionally and in directing students in its use. It is not surprising, then, that we are finding the same is true of the relationship of pedagogy to computer use as a whole: Constructivist-oriented teachers use computers professionally in more varied ways, have greater technical expertise in the use of computers, use computers frequently with students, and use them in apparently more powerful ways. These findings have been explored in several papers to date (Ravitz, Wong, and Becker, 1999; Riel and Becker, 2000; and Becker, 2000a). Further examination of the relationship between teacher pedagogy and computer use will be the topic of a future report.

Finally, although we have already identified teacher role-orientation as a likely determinant of teacher pedagogy, it seems plausible to believe that a teacher's approach to her practice in turn also affects her role-orientation. Thus, while having a "private-practice" role orientation is likely to engender a transmission-oriented practice, teachers who engage in a constructivist pedagogy may actually be more likely as a result to seek out other teachers and become more professionally involved. As with other relationships between variables in our dataset, the direction of causality between pedagogy and role orientation is difficult to disentangle with a cross-sectional survey. A future report will examine the whole set of relationships uncovered and clarify what can be concluded from our data and what remains for new research to discover.

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APPENDIX A: SUPPLEMENTARY TABLES

TABLE A-1: DISTRIBUTION OF ALL TEACHERS REPORTING ACTIVITY BY SUBJECT TAUGHT (PERCENT)

	Monthly Reflective Essays		Weekly Reflective Essays		Monthly Journal Entries		Weekly Journal Entries	
Subject Taught	Middle Grades	High School	Middle Grades	High School	Middle Grades	High School	Middle Grades	High School
English	34	31	43	38	37	45	41	54
Social studies	19	18	14	17	10	10	10	7
Science	15	22	11	23	15	9	14	11
Math	12	7	13	6	14	9	10	4
Foreign Language	2	5	1	3	4	5	2	5
Computers	4	1	4	0	3	2	3	2
Business Ed.	1	4	0	1	0	2	0	3
Vocational	1	3	2	3	2	8	2	7
Fine Arts	1	2	0	1	1	1	2	1
Total	100	100	100	100	100	100	100	100

Sample: Probability sample.

TABLE A-2: SUBJECTS WHERE REFLECTIVE WRITING IS MORE COMMON IN MIDDLE SCHOOL

	Percent Reporting Monthly Writing by Students		
Subject & Level*	Write in Journal	Essay explaining thoughts in length	Essay or discussion seriously assessing own work
Science (MS)	34	44	24
Science (HS)	9	51	19
Math (MS)	23	26	14
Math (HS)	11	21	6
Computer (MS)	24	47	31
Computer (HS)	9	13	12

Sample: Probability sample.
*MS = middle school, HS = high school.

TABLE A-3: REASONS FOR QUESTIONING STUDENTS (PERCENT ASKING QUESTION FOR THE FOLLOWING PURPOSES VERY OFTEN OR ALWAYS)

Subject and Level*	Ask for the correct answer	Check if students did homework	Have students justify or explain their reasoning	Elicit student ideas and opinion	Have students relate work to their own experience
English (MS)	52	29	74	75	70
English (HS)	29	25	78	86	65
Social Studies (MS)	53	28	66	57	49
Social Studies (HS)	52	37	76	76	62
Science (MS)	48	27	60	80	57
Science (HS)	48	31	63	75	51
Math (MS)	69	39	55	93	47
Math (HS)	63	40	56	80	26

Sample: Probability sample.
*MS = middle school, HS = high school.

TABLE A-4: CORRELATIONS AMONG ELEMENTS OF COGNITIVE CHALLENGE AND AMONG ELEMENTS OF ACTIVE LEARNING STRATEGIES, BY TEACHER SUBJECT AND LEVEL

	Correlation Among Elements of Cognitive Challenge		Correlation Among Elements of Active Learning Strategies			
	Reflective Writing & Deep Thinking	Meaningful Thinking & Problem-Solving	Projects & Group Work	Projects & Infrequent Traditional Practices	Groups & Infrequent Traditional Practices	Mean Correlation in Row
English (MS)	.46	.64	.54	.48	.36	.49
English (HS)	.49	.67	.37	.52	.21	.45
Social Studies (MS)	.55	.69	.54	.48	.50	.55
Social Studies (HS)	.55	.72	.35	.36	.16	.43
Science (MS)	.52	.65	.41	.46	.15	.44
Science (HS)	.49	.58	.43	.36	.10	.39
Math (MS)	.49	.63	.45	.50	.32	.48
Math (HS)	.49	.65	.28	.50	−.01	.38
Foreign Language (All)	.39	.46	.30	.33	.11	.32
Computer (All)	.47	.49	.22	.28	.02	.30
Business (All)	.40	.60	.01	.43	.02	.29
Vocational (All)	.47	.45	.51	− .05	− .35	.20
Fine Arts (All)	.58	.72	.28	.20	− .10	.34
Elementary Self-contained	.55	.62	.52	.49	.23	.48
Elementary Other	.62	.57	.46	.52	.23	.48
Mean correlation in column	.50	.61	.38	.39	.13	.40

Sample: Probability and purposive samples.

TABLE A-5: PERCENT OF TEACHERS THAT HAVE STUDENTS WORK IN GROUPS TO COME UP WITH A JOINT SOLUTION OR TO APPROACH A PROBLEM OR TASK WEEKLY OR MORE OFTEN

	Elementary	Middle School	High School	All Teachers
Elementary Self-Contained	59			59
Elementary Other	49			49
English		32	37	34
Social Studies		29	38	33
Science		48	37	42
Math		59	45	52
Foreign Language		45	34	39
Computers		38	30	34
Business		26	24	25
Vocational		43	54	50
Fine Arts		22	20	21
All Teachers	56	42	38	44

Sample: Probability sample.

TABLE A-6: CORRELATIONS BETWEEN COGNITIVE CHALLENGE AND ACTIVE LEARNING STRATEGIES, BY TEACHER SUBJECT AND LEVEL

	Cognitive Challenge & Projects	Cognitive Challenge & Group Work	Cognitive Challenge & Infrequent Traditional Practices	Cognitive Challenge & Active Learning	Mean Correlation in Row
English (MS)	.56	.56	.39	.62	.53
English (HS)	.52	.48	.32	.58	.48
Social Studies (MS)	.48	.54	.29	.55	.46
Social Studies (HS)	.38	.58	.21	.55	.43
Science (MS)	.55	.56	.17	.60	.47
Science (HS)	.54	.57	.14	.60	.46
Math (MS)	.50	.56	.21	.59	.46
Math (HS)	.34	.46	.07	.42	.32
Foreign Language (All)	.40	.23	.32	.43	.34
Computer (All)	.38	.56	−.07	.52	.35
Business (All)	.01	.69	−.31	.35	.19
Vocational (All)	.49	.41	.11	.57	.39
Fine Arts (All)	.36	.52	.04	.53	.36
Elementary Self-contained	.64	.64	.29	.70	.57
Elementary Other	.43	.57	.12	.49	.40
Mean Correlation in Column	.44	.53	.15	.54	.41

Sample: Probability and purposive samples.

TABLE A-7: PERCENT OF SECONDARY TEACHERS UNDERTAKING PROJECTS, AND OVERALL DISTRIBUTIONS OF THOSE PROJECTS ACROSS SECONDARY SUBJECTS

	% of secondary teachers undertaking week long projects, monthly	Distribution of weeklong projects, by secondary subjects (pie chart view)	% of secondary teachers reporting hands on-lab activities monthly	Distribution of hands-on/lab activities, by secondary subject (pie chart view)	Distribution of teachers by subject in the top 50% overall on projects (pie chart view)
English	62	26	51	14	17
Social Studies	44	13	52	10	14
Science	39	16	92	25	20
Math	11	5	53	15	16
Foreign Lang.	27	3	52	4	5
Computers	73	7	99	6	4
Business	59	5	84	5	3
Vocational	67	7	90	6	5
Fine Arts	92	8	91	5	5
All Teachers	45	100	68	100	100

Sample: Probability sample.

TABLE A-8: MEAN Z-SCORES ON CONSTRUCTIVIST PRACTICE IN SELECTED CLASS, BY SUBJECT AND LEVEL

	Constructivist Practice							
	Cognitive Challenge			Active Learning				
	Meaningful Thinking	Problem-Solving	(Cognitive Challenge Index)	Group Work	Projects	Infrequent traditional practices	(Active Learning Index)	(Constr-uctivist Practice Index)
English (MS)	0.45	– 0.27	0.27	– 0.11	– 0.14	0.19	– 0.09	0.16
English (HS)	0.68	– 0.01	0.53	0.17	–0.06	0.68	0.25	0.49
Social Studies (MS)	– 0.16	– 0.51	– 0.29	– 0.24	– 0.23	0.11	– 0.25	– 0.29
Social Studies (HS)	0.19	– 0.17	0.09	0.02	– 0.34	0.06	– 0.21	– 0.01
Science (MS)	– 0.03	0.14	– 0.01	0.26	0.09	0.24	0.22	0.10
Science (HS)	– 0.27	– 0.09	– 0.25	– 0.09	– 0.14	0.09	– 0.12	– 0.21
Math (MS)	– 0.32	0.33	– 0.17	0.02	– 0.68	– 0.55	– 0.64	– 0.38
Math (HS)	– 0.66	0.03	– 0.54	– 0.05	– 0.92	– 0.7	– 0.86	– 0.73
Foreign Language (All)	– 0.27	– 0.58	– 0.44	– 0.19	– 0.21	– 0.58	– 0.50	– 0.51
Computer (All)	– 0.50	0.02	– 0.36	– 0.29	0.97	0.31	0.56	0.02
Business (All)	– 0.71	– 0.78	– 0.82	– 0.76	0.30	– 0.26	– 0.22	– 0.64
Vocational (All)	– 0.26	0.27	– 0.14	0.15	1.11	0.32	0.80	0.27
Fine Arts (All)	– 0.66	– 0.32	– 0.6	– 0.55	1.33	0.66	0.87	– 0.02
Elem. Self-Contained	0.45	0.31	0.42	0.18	0.24	– 0.12	– 0.02	0.36
Elementary Other	0.12	0.13	0.13	0.12	–0.01	– 0.08	0.12	0.09

Sample: Probability sample.
*MS = middle school, HS = high school.

APPENDIX B: SUMMARY OF STUDY METHODOLOGY

The Teaching, Learning, and Computing (TLC) study is comprised of completed questionnaire responses from teachers, principals, and school technology coordinators from three separate samples of schools. 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 (3 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.

The research began in the Spring of 1997 with a validation study of self-report measures of teacher beliefs and practices and exploratory studies of survey measures of changes in teaching practices and technology use and school-level investments in technology hardware, software, and training and teacher support. The validation study provided self-report data from 72 teachers in 24 schools and detailed classroom observation and interview data with those same teachers. At the school level, pilot versions of surveys were used in order to test measurement approaches for studying technology expenditure information, hardware and software acquisition, and investments of time and money in teacher training and support activities.

The data collection itself was the second stage of the project, taking place from January through June of 1998, and conducted by the Battelle Centers for Evaluation and Health Research. Data collection encompassed an initial district contact information letter, followed by a school mailing, in which teachers were rostered and sampled; a subsequent mailing of questionnaires for teachers, the school-level technology coordinator, and the principal; and several waves of mail and telephone followup, editing, coding, data entry, and data cleaning. The teacher respondents were asked to complete a survey booklet about their teaching practice and teaching beliefs that was 21 pages in length and required approximately 60-75 minutes. Four different versions of the teacher survey booklet were used, with overlapping sets of questions. These are called questionnaire

versions 1, 2, 3, and 4. The school technology coordinator's booklet was approximately the same length as the teacher survey and principally concerned the investments their school has made in computer hardware, software, and teacher training and support, measured both financially and in units of time, materials, and equipment. The principal's survey booklet was half as long, and inquired about technology-related school policies and efforts in school restructuring and reform.

The third stage of the project involves data analysis, preparation of reports, and the release of national data files for secondary analysis.

PARTICIPATING SCHOOLS

Across the three samples, 1,215 of the 1,616 schools selected for participation agreed to participate in the study (75%). They did so by returning a roster of a specifically requested number of teachers (10 in elementary schools; 15 in middle and high schools), providing rough estimates of each teacher's use of computers, projects, and emphasis on critical thinking and complex problem-solving. The attained probability 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.

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 schoolwide 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.

Lists of participating schools or teachers were obtained directly from the programs in 44 of the cases; in the other 9 they were obtained from public sources—lists of participants on World Wide Web sites or in books. (In some cases, these were not actually programs—just schools identified as exemplary in the public source.) Forty programs provided more schools than were needed so that probability sampling was employed to select the particular schools that would be incorporated into the study. (In some cases, additional selection criteria were used prior to the sampling.)

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. A Teacher Roster form was sent to

the school principal as the first major mailing to the school (following an introductory letter). That form asked the principal 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 are 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%. This includes 69% of the teachers in the probability sample of schools and 64% in the purposive schools sample. 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.

QUESTIONNAIRES AND WEIGHTING

Participating teachers completed 20+ page questionnaires. Four versions of the questionnaire were used, with largely overlapping questions, but permitting somewhat greater coverage of topics than a single version of equal length would have permitted. The questionnaires dealt with five principal topics: teaching philosophy and related beliefs about instruction and assessment; teaching practices and strategies followed in the instruction of one class—the class in which the teacher felt most satisfied with achieving teaching objectives—; the ways in which the teacher used computers in teaching and professionally and changes over time in the role of computers in her teaching practice; changes in her general pedagogical approaches made over the previous three years; and a wide range of questions about the teaching environment at the teacher's school, including formal professional development, support for technology, informal interactions with other teachers, and pressures experienced in their teaching. In addition, a variety of questions about educational and teaching background and current teaching responsibilities were asked at various points in the questionnaire. Nearly all questions were of the fixed-response type. Open-ended questions about college attended, college major, and current set of courses taught were coded into numerical categories. College attended was coded in terms of selectivity, based on SAT and ACT scores of admitted freshmen in the year 1983.

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. Where purposive and national probability samples are combined, weights are adjusted so that the average weight for teachers in the purposive schools sample is equal to the average weight for teachers from schools in the probability sample.

APPENDIX C: DISTRIBUTION FOR INDIVIDUAL TEACHING PHILOSOPHY ITEMS

TABLE C-1: BELIEFS ABOUT TWO CONTRASTING APPROACHES TO TEACHING

TRADITIONAL APPROACH			VS.		**CONSTRUCTIVIST APPROACH**	
Ms. Hill was leading her class in an animated way, asking questions that the students could answer quickly; based on the reading they 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'** class was also having a discussion, but many of the questions came from the students themselves. 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.	
	% Definitely Ms. Hill	% Tend toward Ms. Hill	% Cannot decide	% Tend toward Mr. Jones	% Definitely Mr. Jones	% Total
Which type of class discussion are you more comfortable having in class?	21	44	7	25	4	100
Which type of discussion do you think most students prefer to have?	20	34	10	28	9	100
From which type of class discussion do you think students gain more knowledge?	14	30	15	29	13	100
From which type of discussion do you think students gain more useful skills?	10	19	14	42	15	100

Sample: Probability sample; questionnaire versions 3 and 4.

TABLE C-2: BELIEFS ABOUT THE FOLLOWING STATEMENTS

	Strongly disagree	Moderately disagree	Slightly disagree	Slightly agree	Moderately agree	Strongly agree
Teachers know a lot more than students; they shouldn't let students muddle around when they can just explain the answers directly.	37	34	14	7	7	1
A quiet classroom is generally needed for effective learning.	15	29	15	20	16	6
Students are not ready for "meaningful" learning until they have acquired basic reading and math skills.	23	18	14	13	18	16
It is better when the teacher - not the students - decides what activities are to be done.	7	20	20	23	22	8
Student projects often result in students learning all sorts of wrong "knowledge."	52	29	11	6	2	1
Homework is a good setting for having students answer questions posed in their textbooks.	8	16	18	30	23	5
Students will take more initiative to learn when they feel free to move around the room during class.	12	18	19	28	19	5
Students should help establish criteria on which their work will be assessed.	7	13	10	32	26	13
Instruction should be built around problems with clear, correct answers, and around ideas that most students can grasp quickly.	14	29	19	18	13	6
How much students learn depends on how much background knowledge they have – that is why teaching facts is so necessary.	10	19	19	27	19	5

Sample: Probability sample; items answered in at least 3 of the 4 versions of the questionnaire.

TABLE C-3: BELIEFS ABOUT THE FOLLOWING PAIRS OF STATEMENTS (PROXIMITY TO THEIR OWN BELIEFS ON A 5 POINT SCALE)

% Constructivist Perspective			Vs.			% Traditional Transmission Perspective
"I mainly see my role as a facilitator. I try to provide opportunities and resources for my students to discover or construct concepts for themselves."	13	27	30	22	8	"That's all nice, but students really won't learn the subject unless you go over the material in a structured way. It's my job to explain, to show students how to do the work, and to assign specific practice."
"The most important part of instruction is that it encourage "sense-making" or thinking among students. Content is secondary."	13	37	31	17	3	"The most important part of instruction is the content of the curriculum. That content is the community's judgment about what children need to be able to know and do."
"It is better for students to master a few complex ideas and skills well, and to learn what deep understanding is all about, even if the breadth of their knowledge is limited until they are older."	8	25	29	29	10	"It is useful for students to become familiar with many different ideas and skills even if their understanding, for now, is limited. Later, in college, perhaps, they will learn these things in more detail."
"It is critical for students to become interested in doing academic work—interest and effort are more important than the particular subject-matter they are working on."	15	40	27	15	3	"While student motivation is certainly useful, it should not drive what students study. It is more important that students learn the history, science, math and language skills in their textbooks."
"It is a good idea to have all sorts of activities going on in the classroom. Some students might produce a scene from a play they read. Others might create a miniature version of the set. It's hard to get the logistics right, but the successes are so much more important than the failures."	20	28	26	20	7	"It's more practical to give the whole class the same assignment, one that has clear directions, and one that can be done in short intervals that match students' attention spans and the daily class schedule."

Sample: Probability sample.

APPENDIX D: DISTRIBUTION FOR INDIVIDUAL TEACHING PRACTICE ITEMS

TABLE D-1: IN INTRODUCING THE CURRENT UNIT TO THEIR SELECTED CLASS* (FIRST TWO OR THREE LESSONS), PERCENT THAT TOOK THE FOLLOWING APPROACHES

In introducing the current unit...	Component	% Did not use and rarely do	% Did not use but often do	% Used this time	% Total
I offered the class a reward for doing well	-	80	11	9	100
I had the students do introductory drills	T	35	20	45	100
Students discussed the topic in small groups	G	29	34	37	100
I asked students to make conjectures	M	21	28	51	100
I raised questions about the unit	M	52	26	22	100

Sample: Probability sample.
*Class in which teacher most often accomplishes their teaching goals.
M=Component of Meaningful Thinking Index.
S=Component of Problem-Solving Index
G=Component of Group Work Index.
P= Component of Project Index.
T=Component of Infrequent Traditional Practices Index.

TABLE D-2: PERCENT REPORTING THE FOLLOWING ACTIVITIES OVER THE LAST 5 HOURS IN THEIR SELECTED CLASS*

	Component**	Under 30 minutes	30-60 minutes	1-1/4 to 2 hours	Over 2 hours	% Total
Teacher led a whole-class discussion	T	33	34	21	12	100
Students led a discussion or gave a presentation	M	52	32	13	3	100
Students worked on their own on assignments at their desks	-	24	35	26	14	100
Students worked together in small groups to complete an assignment as a team	G	21	28	30	21	100

Sample: Probability sample; questionnaire versions 3 and 4.
*Class in which teacher most often accomplishes their teaching goals.
**See Table D-1 for key to abbreviation.

TABLE D-3: HOW OFTEN STUDENTS IN SELECTED CLASS* TAKE PART IN THE FOLLOWING ACTIVITIES

How often do students...	Com-ponent**	% Never	% Some-times	% 1-3 times per month	% 1-3 times per week	% Almost everyday	% Total
Work individually answering questions	P	8	24	15	34	19	100
Do hands-on/laboratory activities	P	9	20	21	32	19	100
Work on projects that take a week or more	P	10	42	28	8	11	100
Write in a journal	M	43	22	7	11	16	100
Suggest or help plan classroom activities or topics	M	21	54	17	6	3	100
Work in small groups to come up with a joint solution	G,S	6	27	24	30	14	100
Work on problems for which there is no obvious solution	S	27	39	17	12	5	100
Write an essay explaining their thoughts in length	M	19	31	28	18	4	100

Sample: Probability sample.
*Class in which teacher most often accomplishes their teaching goals.
**See Table D-1 for key to abbreviation.

TABLE D-4: HOW OFTEN TEACHERS ARE TRYING TO ACCOMPLISH THE FOLLOWING GOALS WHEN ASKING QUESTIONS OF STUDENTS IN THEIR SELECTED CLASS*

How often do you try to...	Com-ponent**	% Never	% Sometimes	% Often	% Very often	% Always	% Total
See if students know the correct answer	T	1	18	28	37	16	100
See if students have done the homework	-	10	30	27	24	8	100
Elicit students ideas and opinions	M	0	7	24	45	23	100
Get students to justify and explain their reasoning	M	1	6	18	44	32	100
Have students relate to their own experiences	M	2	17	24	38	20	100

Sample: Probability sample.
*Class in which teacher most often accomplishes their teaching goals.
**See Table D-1 for key to abbreviation.

TABLE D-5: HOW OFTEN TEACHERS GIVE THE FOLLOWING TYPES OF ASSIGMENTS TO THEIR SELECTED CLASS*

How often do students...	Com-ponent**	% Never	% Some-times	% 1-3 times per month	% Once a week or more	% Total
Hold a debate and argue for a point of vie	M	44	44	10	3	100
Have to design their own problems to solve	S	28	50	16	6	100
Decide on their own procedures for solving a problem	S	16	45	26	13	100
Assess their own work on an assignment	M	29	40	24	7	100
Have to represent the same idea in more than one way	M	17	41	29	13	100
Make a product that will be used by someone else	P	46	41	9	3	100
Demonstrate their work to an audience	P	53	35	9	2	100
Have tasks for which there is no correct answer	M	31	46	17	7	100

Sample: Probability sample.
*Class in which teacher most often accomplishes their teaching goals.
**See Table D-1 for key to abbreviation.

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