Building a Science of Classrooms: Application of the CLASS Framework in over 4,000 U.S. Early Childhood and Elementary Classrooms

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Abstract

The elucidation and validation of a broad theory of classrooms is critical to the advancement of education sciences and integrally linked to psychology's contribution to these sciences. This paper presents one such theoretical model, the CLASS Framework (Hamre & Pianta, 2007), which organizes teacher-student interactions into three major domains, and empirically tests this model across the largest sample of standardized observations in preschool and elementary classrooms available to date. Results provide evidence that: 1) classroom interactions are comprised of distinct emotional, organizational, and instructional domains; 2) the CLASS 3-factor latent structure is a better fit to observational data than alternative 1- and 2-domain models of classroom interactions, and, 3) the 3-domain structure is generalizable from preschool through fifth grade. The CLASS Framework serves as a useful heuristic for studying many significant issues in the field of education and can serve as the basis for systematic, rigorous, and progressive research on classroom effects and teacher education, which in turn can lead to significant, scientifically based improvement in American education.

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in over 4,000 U.S. Early Childhood and Elementary Classrooms

Two converging forces dominate discussion about elementary education in the United States, both of which reflect accountability in some form—attention to the quality and productivity of America's classrooms and increased pressure for rigor and relevance in educational research. This paper presents findings at the intersection of these forces—a theoretical model that organizes teacher-student interactions, the CLASS Framework (Hamre & Pianta, 2007), is empirically tested across the largest sample of standardized observations in preschool and elementary classrooms available to date. Using broad-scale, direct investigation to validate a comprehensive theory of classroom processes is expected to serve as the basis for systematic, rigorous, and progressive research on classroom effects and teacher education, which in turn can lead to significant, scientifically based improvement in American education.

Consistent with the focus of No Child Left Behind (NCLB) legislation, which focuses on holding individual schools and classrooms accountable for producing academic gains for all students, investigators interested in studying educational processes and outcomes must respond to the rigorous standards established for peer review through the recently reorganized Institute of Education Sciences (IES). The vast majority of research supported by IES now adheres to a pair of fundamental principles that reflect the forces noted at the outset of this paper: most projects examine classroom level processes (e.g., curriculum, early reading interventions, teacher quality) that have practical implications for teachers and administrators in the trenches; and, they do so using analytic methods and research designs that to the extent possible support causal inferences. Over time, one expects a twofold result—scientifically-based solutions for challenges facing American education and the construction of empirically-based theories of teaching and learning that serve as the foundation for understanding education and developing new solutions.

As noted in the National Academies book *Scientific Research in Education* (Shavelson, Towne, & the Committee on Scientific Principles for Education Research, 2002), the progression of education research, like all sciences, requires the construction and evaluation of integrative theories that help guide

research. The purpose of the current report is to describe a recently articulated theory of classroom practice, based on observational studies in pre-kindergarten and kindergarten classrooms and then empirically test the adequacy of this theoretical framework for describing classroom processes in a national sample of more than 4,000 classrooms extending from preschool to fifth grade. Specifically, we test the degree to which Hamre and Pianta's (2007) CLASS Framework, a theory that organizes classroom interactions and processes into three broad domains—Emotional Support, Classroom Organization, and Instructional Support, is consistent with observational data collected in a large sample of classrooms across the United States.

The elucidation and validation of a broad theory of classrooms is critical to the advancement of education sciences and integrally linked to psychology's contribution to these sciences. Few areas of educational research are of greater concern in the current, accountability-driven world of schools than research on classroom and teacher effects; such research asks the central question—what are the mechanisms through which students' experiences in classrooms contribute to their academic and social development? Although understanding the effects of classrooms on student outcomes has been a focus of educational and psychological research for over three decades (e.g., Brophy, 1999; Brophy & Good, 1986; Eccles & Roeser, 1999; Gage, 1978; Pressley et al., 2003; Soar & Soar, 1979), this research, we argue, has not had a powerful impact on educational policy or practice precisely because it has not combined theory, rigorous methods, and capacity for large scale application. Thus, the available evidence related to classroom processes and effects, based on actual observations does not produce an empirically-supported consensus among researchers, teachers, and school administrators about what aspects of classrooms contribute most to children's academic and social development. In the present study, we address the question of classroom effects through the method of standardized classroom observations in large samples—that is, we focus not only on the putative mechanisms responsible for classroom effects, but also their potential to be reliably observable across a wide range of ages, grades, schools, catchments, and assorted background characteristics.

Building a Science of Classroom and Teacher Effects

As Shavelson and colleagues (2002) contend, educational science must move forward through a "dynamic interplay among methods, theories, and findings" (p. 2). Consistent with this argument, the development of the CLASS Framework has progressed through a series of discrete steps—posing significant questions, building theory, conducting direct investigations, and then evaluating the theory's generalizability—in order to build a *science of classrooms*. In the section below, we provide a brief overview of how the CLASS Framework is positioned in regard to Shavelson et al.'s (2002) proposed steps toward the development of a scientific program. This overview then culminates with an elaboration of the goal for the current report, which is to assess the extent to which the CLASS Framework can be broadly applied and generalized across samples and grade levels.

Posing Significant Questions

There is little debate that research focused on classroom effects holds promise; however, the way in which questions are framed have important implications for the degree to which findings are useful to practitioners and policymakers, and ultimately to the goal of progressive and systematic improvement of classrooms' impacts on students. For example, numerous studies relying on sophisticated multi-level analyses of large-scale student achievement test outcomes indicate that: 1) a significant portion of variance in student learning is explained at the classroom level (Hanushek, 2002; Nye, Kostanopoulos, & Hedges, 2004); and 2) deflections in the trajectory of student learning across years can be attributed to their experiences in specific classrooms (Hamre & Pianta, 2005; Sanders & Rivers, 1996). These studies support the conclusion that classroom experiences matter but fail on two counts: 1) identifying specific processes that lead to student learning and positive social adjustment and, 2) anchoring classroom effects in verifiably observable indicators, both of which are critical to the capacity of scientific inquiry to advance the training of teachers and improvement of classrooms.

To pose matters differently, although these studies show that inputs matter, they are completely uninformative regarding the critical challenge of how to systematically regulate and produce effective inputs. This agnosticism with regard to understanding, assessing, and producing classroom effects is highlighted in recent debates about teacher education and teacher education research. Hanushek's (2002)

definition of teacher quality, "Good teachers are ones who get large gains in student achievement for their classes; bad teachers are just the opposite" (p. 3), as well as much of the "value-added" paradigm (Sanders & Rivers, 1996; Webster & Mendro, 1997), provide no guidance to the development of a scientifically-driven agenda aimed at evidenced-based ways to improve teaching and teacher education (Cochrane-Smith & Zeichner, 2005). The critical questions are no longer about attributing variance in student achievement gains to classrooms, rather they involve the mechanisms through which classrooms exert their influence on children's development and how such effects can be more reliably produced and maximized. The CLASS Framework, with its focus on processes and interactions between teachers and students in the classroom, helps set the stage for asking these types of questions.

Building a Theory

The CLASS Framework (Hamre & Pianta, 2007) draws heavily from earlier theoretical and empirical work in the educational and psychological literatures (e.g., Brophy, 1999; Brophy & Good, 1986; Eccles & Roeser, 1999; Gage, 1978; Pressley et al., 2003; Soar & Soar, 1979) to describe an overarching theory of classroom practice. This conceptual framework is the starting point for systematic progress toward a science of classrooms that: 1) is based on theories of children's development and schooling, 2) is applicable with regard to relating inputs (e.g., teacher training) and outputs (e.g., student learning) across a broad range of educational settings, and 3) relies upon and generates metrics for assessing classrooms that can be usefully and validly incorporated into solution-oriented policies and practices. The CLASS Framework focuses on *proximal processes* in classroom settings (Bronfenbrenner & Morris, 1998)—the interactions that take place among teachers and students on a daily basis. These interactions are viewed as the primary mechanisms through which schools afford students opportunities to become engaged in academics, develop social skills, and, ultimately, develop competencies.

The CLASS Framework (see Figure 1) posits three broad domains of classroom interactions involving teachers and children that are hypothesized to be important in promoting student learning and social development—Emotional Support, Classroom Organization, and Instructional Support. This framework is consistent with other perspectives on classroom process. Brophy (1999) describes 12

principles of effective teaching, including supportive classroom climates, opportunities to learn, curricular alignment, thoughtful discourse, and scaffolding engagement, each of which are based on research findings and theories of teaching and learning. Emerging from studies of effective teachers (e.g., Bognier, Raphael, & Pressley, 2002; Pressley, Allington, Wharton-McDonald, Block, & Morrow, 2001), Pressley and colleagues (2003) propose that teaching strategies can be organized into—creation of a motivational atmosphere, classroom management, and curricular and instructional decisions. Eccles and Roeser (1999) suggest that schools are characterized by organizational, social, and instructional processes. In the CLASS framework, each broad domain is then comprised of several specific dimensions of interactions; for example, Emotional Support consists of three dimensions—Classroom Climate, Teacher Sensitivity, and Regard for Student Perspectives. Each of these dimensions, in turn, is described by explicit categories or indicators of that dimension, which are then operationalized in specific behavioral, observable descriptions of classroom interactions, either between teachers and students or among students.

The model proposed by Hamre and Pianta (2007) describes a *multi-level, latent structure* in which are organized a wide range and large number of teacher behaviors. The more typical approach to defining what happens in classrooms has involved long lists of teacher and student behaviors, often of varying degrees of molarity/discreteness, and each of which holds equal weight in determining the value of that setting. The multi-level latent structure of the CLASS Framework has the distinct advantage of positing an underlying organization of teaching and teacher-student interaction that lends itself to a more systematic, coherent view of classroom interactions (Pianta, La Paro, & Hamre, in press). With a few notable exceptions (Eccles & Roeser, 1999; Pressley et al., 2003), the CLASS Framework is also more comprehensive than most other models of classroom practice by emphasizing the social and emotional components of the classroom and dimensions of instructionally-relevant interactions that emphasize the presentation of information to facilitate higher order thinking skills and advanced cognition (Bransford, Brown, & Cocking, 1999; Mayer, 2002).

A final distinction between the CLASS Framework and other conceptualizations of classrooms is that the focus on a latent structure of proximal processes was conceptualized to apply to classroom

contexts across all grades, from preschool to high school; thus, the 3-domain latent structure is hypothesized as grade-invariant. Critically, although latent structure is hypothesized as *invariant*, the CLASS Framework reflects the developmentally-relevant construct of *heterotypic continuity* and allows for variation across grades in the dimensions of teaching and the specific behavioral indicators organized within dimensions. Nonetheless, the overall latent structure of three broad domains is assumed to remain constant, thus revealing a hypothesis that can be subjected to empirical test in the next phase in building the science of classrooms—direct observation and validation of this theory in actual classrooms. In the next section, we briefly review the three major domains of learning opportunities described in the CLASS Framework, including a summary of the developmental theories and empirical studies on which they are based.

Emotional support. Teacher efforts to support students' social and emotional functioning in the classroom, through positive facilitation of teacher-student and student-student interactions, are key elements of effective classroom practice. Two broad areas of developmental theory guide much of the work on emotional support in classrooms—attachment (Ainsworth, Blehar, Waters, & Wall, 1978; Bowlby, 1969; Pianta, 1999) and self-determination theory (Connell & Wellborn, 1991; Ryan & Deci, 2000; Skinner & Belmont, 1993). Attachment theorists posit that when parents provide emotional support, and a predictable, consistent, and safe environment, children become more self-reliant and are able to take risks as they explore the world because they know that an adult will be there to help them if they need it (Ainsworth et al., 1978, Bowlby, 1969). This theory has been broadly applied to and validated in school environments (Birch & Ladd, 1999; Hamre & Pianta, 2001; Howes, Hamilton, & Matheson, 1994; Lynch & Cicchetti, 1992; Pianta, 1999). Self-determination (or self-systems) theory (Connell & Wellborn, 1991; Ryan & Deci, 2000; Skinner & Belmont, 1993) suggests that children are most motivated to learn when adults support their need to feel competent, positively related to others, and autonomous. Throughout schooling, students who are more motivated and connected to teachers and peers demonstrate positive trajectories of development in both social and academic domains (Hamre & Pianta, 2001; Harter, 1996; Ladd, Birch, & Buhs, 1999; Pianta, Steinberg, & Rollins, 1995; Roeser,

Eccles, & Sameroff, 2000; Ryan, Stiller, & Lynch, 1994; Silver, Measelle, Essex, & Armstrong, 2005; Wentzel, 1998).

Classroom organization. Educational research and practice place tremendous emphasis on the role of organization and management in creating a well-functioning classroom. In the CLASS Framework, classroom organization is a broad domain of classroom processes related to the organization and management of students' *behavior*, *time*, and *attention* in the classroom (Emmer & Stough, 2001). From a developmental standpoint, research on children's self-regulatory skills provides the theoretical underpinnings of this domain (Blair, 2002; Paris & Paris, 2001; Raver, 2004; Tobin & Graziano, 2006), including focus on the development of memory, attention, planning, and inhibitory control, all of which have clear relevance to success in classroom environments. Children's self-regulatory behaviors are multi-determined, with family processes (e.g., parental sensitivity) and individual differences (e.g., temperament) contributing to children's ability to self-regulate in home, school and laboratory environments (e.g., Blair, 2002; Connell & Wellborn, 1991; Grolnick & Ryan, 1989; Rimm-Kaufman, Early, & Cox, 2002; Rubin, Coplan, Fox, & Calkins, 1995; Tobin & Graziano, 2006). Recent advancements in developmental neuroscience, suggesting rapid growth and changes in brain areas associated with self-regulation during early childhood years, have placed particular emphasis on the role of preschool and elementary classrooms in developing these skills (Blair, 2002). Classrooms using more effective behavior management strategies (Arnold, McWilliams, & Arnold, 1998; Emmer & Strough, 2001; Evertson, Emmer, Sanford, & Clements, 1983; Evertson & Harris, 1999), having more organized and routine management structures (Bohn, Roehrig, & Pressley, 2004; Cameron, Connor, & Morrison, 2005), and implementing strategies that make students active participants in classroom activities (Bowman & Stott, 1994; Bruner, 1996; Rogoff, 1990; Vygotsky, 1978) have less oppositional behavior, higher levels of engagement in learning, and ultimately, students who learn more.

Instructional support. Instructional methods have been put in the spotlight in recent years, as more emphasis has been placed on the translation of cognitive science, learning, and developmental research to educational environments (Carver & Klahr, 2001). The theoretical foundation for the

conceptualization of instructional supports in the CLASS Framework comes primarily from research on children's cognitive and language development (e.g., Catts, Fey, Zhang, & Tomblin, 2001; Carver & Klahr, 2001; Fujiki, Brinton, & Clarke, 2002; Romberg, Carpenter, & Dremlock, 2005; Taylor, Pearson, Peterson, & Rodriguez, 2003; Vygotsky, 1991; Wharton-McDonald, Pressley, & Hampston, 1998). This literature highlights the distinction between simply learning facts and gaining "usable knowledge," which is built upon learning how facts are interconnected, organized, and conditioned upon one another (Bransford et al., 1999; Mayer, 2002). A student's cognitive and language development is contingent on the opportunities adults provide to express existing skills and scaffold more complex ones (Davis & Miyake, 2004; Skibbe, Behnke, & Justice, 2004; Vygotsky, 1991). The development of "metacognitive" skills, or the awareness and understanding of one's thinking processes, is also critical to children's academic development (Veenman, Kok, & Blöte, 2005; Williams, Blythe, & White, 2002). The exemplary work of the National Research Councils series, *How Students Learn* (Donovan & Bransford, 2005), summarizes research across disciplines to emphasize how specific teaching strategies can enhance students' development and application of these core thinking skills (Bransford et al., 1999).

Direct Investigation—The Importance of Classroom Observation

Science does not progress solely on the basis of theory; in fact, we might argue that one source for the lack of progress in developing solutions for educational problems is overemphasis on theorizing and scant efforts to evaluate these theoretical musings. Thus, the third principle discussed in *Scientific Research in Education* (Shavelson et al., 2002) is the need for theory to be tested using methods that allow for direct investigation, confirmation, or refutation. In the case of the science of classrooms, this requires direct observation (Gage, 1978) and validation of observed classroom processes and verification that what is being observed actually accounts for gains in student learning. The CLASS theoretical framework is directly tied to an observational measure of classroom processes (CLASS: Pianta et al., in press) that helps build the bridge between theoretical assumptions about important classrooms processes and actual observations of these processes in real classrooms.

Importantly, it has also been demonstrated that measures of classroom process informed by the CLASS Framework do indeed predict student performance. For example, adjusting for selection effects and prior student functioning, observed Emotional Support predicts student performance in standardized tests of early literacy in preschool and first grade (NICHD ECCRN, 2003); lower levels of internalizing behaviors reported by mothers in kindergarten and first grade (NICHD ECCRN, 2003); and, student's behavioral engagement with classrooms across several elementary grades (Bryant et al., 2002; NICHD ECCRN, 2002). Similarly, Instructional Support consistently predicts student's academic functioning in preschool (Howes, Burchinal, Pianta, Bryant, Early, Clifford, & Barbarin, in press; Mashburn et al., 2007), and behavioral engagement in first grade classroom activities (NICHD ECCRN, 2003). These direct investigations indicate that the CLASS Framework measures valid aspects of classroom process across assorted student bodies and grade levels.

Broad Applicability and Generalization

A final principle of relevance to a science of classrooms is theory that can be applied broadly through replication and generalization. Previous theories of classroom process have either not been submitted to rigorous empirical validation, or if validated, studies have been small-scale and often grade-specific (Brophy, 1999; Brophy & Good, 1986; Eccles & Roeser, 1999; Gage, 1978; Pressley et al., 2003; Soar & Soar, 1979) thus limiting generalizability. In the next section, we report results drawing from a sample of just over 4,000 preschool to fifth grade classrooms that were a part of several large, national and regional studies that cover a broad array of classroom contexts, including public and private schools, rural, suburban, and urban environments, and schools with very diverse student bodies. The observational data from these studies provide a robust test of the ways in which a specific theory of classroom settings can be applied to a broad spectrum of early childhood and elementary classrooms in the United States.

To test the applicability and generalizability of the CLASS Framework as a theory of classroom settings, we first examined observational instruments used in these large-scale investigations and sorted observed dimensions of classroom process into the domains described by the CLASS Framework. Next, we used confirmatory factor analysis to examine the extent to which the 3-domain latent structure posited

in the CLASS Framework fit the natural variation in observed classrooms processes. Finally, we used confirmatory factor analysis to test alternative organizational structures for classroom interactions. The first alternative model posits a single domain of effective teaching, which is what would be suggested by many of the large-scale modeling of achievement data that attributes the source of student learning gains to classrooms (e.g., Sanders & Rivers, 1996). The second alternative model posits two domains, social and instructional supports. This model can be derived from a focus on classrooms that is isomorphic with the two most frequently assessed areas of student outcomes (achievement and social skills) and is consistent with some of the organizational frameworks that have been suggested in narrative reviews of classroom processes (Brophy, 1999; Pressley et al., 2003). Consistent with the theoretical and empirical data cited above, we expected that the 3-domain model, in which dimensions were organized under Emotional, Organizational, and Instructional interactions, would overall provide a better fit to the data than either of the two alternative models.

Background

Studies

The present study utilizes data from four large-scale, observational research projects conducted from 1998 to 2005 in over 4,000 preschool to fifth grade classrooms across the United States. Basic information for each study and the classroom observations are included below and in Table 1. Readers are referred to individual study citations for more complete information on the data collection procedures and sample.

MyTeachingPartner (MTP). MyTeachingPartner (Pianta et al., 2007) is a NICHD-funded professional development project targeting the quality of pre-kindergarten teachers' classroom interactions with students. Two hundred forty teachers were recruited to participate across 41 school districts; videotapes of classroom interactions were available for 152 of these teachers during the 2004-2005 academic year and were included in the current study.

National Center for Early Development and Learning Multi-State Study of Prekindergarten (NCEDL MS). The NCEDL MS (Early et al., 2005; Pianta et al., 2005) was conducted in six states with

state-funded preschool programs. In each state (or large metropolitan area within the state), a stratified random sample of 40 preschool centers or schools was selected from a list provided by the state's department of education. Of the initial sites that were eligible, 78% agreed to participate, resulting in 240 pre-kindergarten classrooms enrolled across the 2001-2002 academic year. These children were then followed into 737 kindergarten classrooms which were also included in these analyses (Hamre, La Paro, LoCasale-Crouch, & Pianta, 2006).

NCEDL State-Wide Early Education Programs Study (NCEDL SWEEP). The NCEDL SWEEP (Early et al., 2005) study was conducted in five states that were selected to complement those included in the NCEDL MS sample, mainly to diversify funding and delivery models. This study set out to randomly select 100 preschool centers from each state (or regions within state with large metropolitan areas), resulting in a total of 454 classrooms enrolled in the study across the entire 2003-2004 academic year.

National Institute of Child Health and Human Development Study of Early Child Care and Youth Development (NICHD SECCYD). The NICHD SECCYD (NICHD ECCRN, 2002, 2005; Pianta, Belsky, Vandergrift, Routs, Morrison, & the NICHD ECCRN, in press) is a longitudinal study of key developmental contexts for children from birth through 8th grade. Families were recruited through hospital visits to mothers shortly after the birth of a child in 1991 at ten locations in the U.S. Of the initial pool of eligible mothers contacted for participation, 1,364 completed a home interview when the infant was one month old and became study participants. Relevant to this study, participating children were followed into their first grade (N = 834), third grade (N = 827) and fifth grade (N = 791) classrooms.

Observational Methods

Data for the present study were obtained through classroom observations. Each study used fairly consistent measurement strategies, relying on global rating scales of classroom interactions falling into the three domains described by the CLASS Framework. Either the Classroom Assessment Scoring System (CLASS) or Classroom Observation System (COS) was used in each of the projects. The individual scales measured by each of these systems are described in Table 2.

Classroom Assessment Scoring System (CLASS; Pianta, La Paro, Hamre, in press). The CLASS was developed to assess classroom quality from preschool to high school (see www.classobservation.com); however, the versions of the CLASS used in this report focused on preschool to third grade. An early version of the CLASS used in the NCEDL studies contained nine dimensions, whereas the current version used in MTP contained 10. Across studies, ratings were made on a 7-point scale, ranging from "Low" to "High" for the following dimensions: positive climate, negative climate, teacher sensitivity, regard for student perspectives, behavior management, instructional learning formats, productivity, concept development, quality of feedback, and language modeling. One dimension from the CLASS used in the NCEDL studies, overcontrol, was significantly revised due to problems with limited variability and skewness into the new dimension Regard for Student Perspectives; overcontrol, therefore, was not used in current analyses. Adequate criterion and predictive validity have been demonstrated for the CLASS, including associations with other measures of classroom quality (Pianta et al., 2005), gains on standardized assessments of academic achievement, and improved social adjustment (Burchinal et al., 2005; Howes et al., in press; Mashburn et al., 2007).

COS-1, -3, -5. The first, third and fifth grade versions of the COS were developed specifically for use in the NICHD SECCYD, based on the kindergarten version (COS-K; CITE!), to track child behaviors and classroom conditions. The COS uses a multi-level observation format that incorporates both discrete codes and global ratings; only the global ratings of classroom quality were used in this study. Ratings were made on a 7-point scale, ranging from "Uncharacteristic" to "Extremely Characteristic" for the following dimensions: literacy instruction, evaluative feedback, instructional conversation, encouragement of child responsibility, positive emotional climate, negative emotional climate, classroom management, teacher sensitivity, richness of instructional methods, and classroom chaos. Adequate predictive validity has been established for the COS measures with a host of NICHD SECCYD studies reporting COS-assessed classroom effects on changes in children's academic and social functioning (Hamre & Pianta, 2005; NICHD ECCRN, 2003, 2005; Pianta et al., 2007).

Training and reliability. Across studies, all observers attended a centralized workshop to attain reliability on the CLASS or COS, prior to which they read a manual with extensive descriptions of dimensions and anchor points and practiced coding with several videotape clips. The workshops consisted of guided practice with coding videotaped classroom footage. After the training workshops, observers had to pass a videotaped reliability test, involving either five or six cycles of 20-44 minutes. Criteria for passing were at least 80% match (within one scale point) with master codes on the global rating scales. All coders passed at these levels on the reliability test before being certified to conduct observations in the field.

Procedures. Data were collected at different times during the year and in different cycles during the day of observation for each of the research projects (see individual study reports for more details). However, detailed analyses of data from both the CLASS and COS, as reported in the technical manual for the CLASS, indicate that modifications in observational strategies generally have small effects on overall results (Pianta et al., in press). For example, the stability of classroom process is indicated by the results from one study in which the average classroom was observed for 15, 20-minute cycles over two days. Composites generated after only 4 cycles of observation were highly associated with the 2-day composites, with correlations ranging from .84 for Productivity to .91 for Concept Development.

Classroom observations took place in the winter-to-early spring period of first, third and fifth grades using the COS. Within NCEDL MS kindergarten and NICHD SECCYD 3rd and 5th grade classrooms, observations occurred for an entire school day, except for recess, lunch, and nap. Within NICHD SECCYD 1st grade classrooms, observations occurred during the morning, began with the official start of the school day, and lasted approximately 3 hours. In NCEDL MS and SWEEP pre-k classrooms, observers coded for an entire day in half day programs and until nap time in full day programs. Finally, for MTP pre-k classrooms, teachers were provided with a video camera and tripod and asked to videotape themselves for a minimum of 30 minutes once every two weeks; this video footage was supposed to include a lesson from either a language/literacy or socio-emotional curriculum. Observers then coded the

first 30 minutes of the videotape. Scores used here were averaged across observations made during the entire school year.

An Empirical Test of the Theoretical CLASS Framework

For each of the seven data sets of classroom observations, four experts used the theoretical foundation of the CLASS framework to place each of the individual rating scales used in a study into a single CLASS domain of emotional support, classroom organization or instructional support. There was 100% agreement in the experts' placement of all scales. Next, a measurement model was estimated separately for each of the seven sets of classroom observations that tested the magnitude of the associations between each scale and its corresponding factor and the overall fit of the theoretical three-factor model. The fit of this three-factor measurement model identified by the CLASS framework was contrasted with two alternative specifications. A two-factor measurement model was tested, which proposed that each scale was a measure of either the emotional support domain or the instructional support domain; a one-factor measurement model was also tested, which proposed that each scale measures a single dimension of overall observed classroom interactions. Each measurement model was estimated with the Analysis of Moment Structures program (AMOS; Arbuckle, 1999) using maximum likelihood estimation on covariance matrices.

Testing Three Measurement Models of Observed Classroom Interactions

For the three-factor, two-factor, and one-factor measurement models tested for each of the seven sets of classroom observations, standardized regression weights for each item and indices of overall model fit were reported. Standardized regression weights indicate the magnitude and direction of the association between each item and the corresponding factor in terms of standard deviation units. Fit indices estimate the extent to which the proposed measurement model fits the observed data. Numerous indices for evaluating the overall fit of the models are available that use different theoretical frameworks and that address different components of model fit (Mulaik, James, Van Alstine, Bennett, Lind, & Stilwell, 1989; Browne & Cudeck, 1993; Hu & Bentler, 1995), and Tanaka (1993) recommends examining multiple indices when evaluating the overall fit of a model in order to assess different aspects

of fit. We report five different fit indices, which allow us to contrast the relative fit of the three-, two- and one-factor models, and to assess the fit of each measurement model compared to the following standards of acceptable fit for each index. Chi-squared divided by the degrees of freedom with values below 2 are commonly taken to indicate good fit. Three fit indices assess the "goodness of fit" of a measurement model along a scale ranging from 0 to 1—Goodness-of-Fit index (GFI), the Tucker-Lewis Index (TLI), the Comparative Fit Index (CFI)— and values above .90 can be taken as evidence for of a good-fitting model (Bentler & Bonnet, 1980). In the case of the Root Mean Square Error of Approximation (RMSEA), smaller values indicate better fit, and values of .08 or lower are generally used to indicate acceptable model fit (Klein, 1998). In addition to standardized regression weights and fit indices, reliability estimates (Cronbach's alphas) of the proposed factors are presented, which provide an index of the internal consistency of each factor specified in the measurement model.

Results from the three-factor, two-factor, and one-factor measurement models of observed classroom interactions are presented in Table 3, Table 4, and Table 5, respectively. The five indices that evaluate the overall fit of the models across the seven sets of classroom are presented in each table, and results indicate that across all fit indices, the three-factor model provides the best overall fit to the observed data relative to the fit of the two-factor and one-factor models. The fit of the three-factor model was also compared to the standards of acceptable fit for each fit index. The three "goodness of fit" indices for the three-factor measurement models across the seven sets of observations indicate generally acceptable fit with indices above or approaching 0.90. The chi-square divided by degrees of freedom were inflated above what is considered good fit for each model, which is likely due to the large sample sizes and skewed distributions of many of the variables. In addition, the RMSEA's ranged from 0.08 to 0.17, which is higher than what is typically accepted for good model fit. The RMSEA is sensitive to the size of the model, and a better fit results from models that include greater numbers of variables (Breivik & Olsson, 2001; Kenny & McCoach, 2003); thus, the lack of fit may, in part, be the result of the relatively small number of variables included in each model.

Table 3 presents reliability estimates (Cronbach's alphas) for the emotional support, classroom organization, and instructional support factors specified in the three-factor measurement model. The internal consistencies were generally acceptable (ranging from alpha=.77-.89) for the emotional support factor across all seven studies and for the classroom organization and instructional support factors in the four studies involving pre-kindergarten and kindergarten classrooms. Internal consistencies were considerably lower for the classroom organization and instructional support factors observed within 1st, 3rd, and 5th grade classrooms, however, this is likely due to the smaller number of scales available for those domains at those grade levels. Internal consistencies presented for each factor in the two-factor model (Table 4) and for the overall factor in the one-factor model (Table 5) also achieved acceptable levels of internal consistency across the data sets.

Implications and Applications

The science of education, like any other science, advances through stages of posing significant research questions, building theories, testing theories, and evaluating the degree to which theories generalize to different individuals and settings (Shavelson et al., 2002). Education research, policy, and practice are faced with the daunting task of unpacking the "black box" of classroom process—the observable, everyday classroom experiences that contribute to students' development of academic and social competencies. The CLASS Framework (Hamre & Pianta, 2007) posits that classroom effects are located in the interactions that take place between teachers and students and at all grades these interactions are organized into three domains—Emotional Support, Classroom Organization, and Instructional Support. The present study was a direct test of this theory across more than 4,000 preschool through fifth grade classrooms. Although in some cases the statistical model fit the proposed theory at levels below what is conventionally considered "good" fit, results provide evidence that: 1) classroom interactions are comprised of distinct emotional, organizational, and instructional domains; 2) the CLASS 3-factor latent structure is a better fit to observational data than alternative 1- and 2-domain models of classroom interactions; and, 3) the 3-domain structure is generalizable from preschool through fifth grade.

The study was not without limitations. There was variation across studies in the clusters of specific dimensions of classroom interaction that were assessed, and there was slight variation in some of the lower-level behavioral indicators. Moreover, the inter-rater reliabilities for the global rating scales used in these studies, while adequate, were not as strong as might be desirable, reflecting some un-estimated degree of rater influence on the scores used. Interestingly, Raudenbush (2004) has applied generalizability theory to decompose error variance in observational measures of classroom process to result in more precise estimates of an assortment of usually un-estimated effects (e.g., rater, day, setting). Although these scales have shown to be valid predictors of growth in student outcome attributable to classrooms (Hamre & Pianta, 2005; Howes et al., in press; Mashburn et al., 2007), we nonetheless note that such effects are not large. Finally, as indicated by Hanushek and others it is possible that measurements of teacher-student interactions are influenced by characteristics of individual students or the group more generally, and so interpretations of these results as indicative of only teacher effects are premature.

Notwithstanding these caveats, a key finding bolstering the potential importance of these findings for building a scientifically-based approach to enhancing quality and value of student-teacher interactions is evident in results from an evaluation of a professional development intervention designed to *change* teachers' interactions with students (Pianta et al., 2007). Using the CLASS observational tool as the metric for the quality of teacher-student interactions, Pianta and colleagues provided teachers with feedback on their interactions using a combination of video and text, with results indicating that ongoing engagement in a cycle of feedback produced significant gains in the quality of teachers' interactions with students for dimensions reflective of each of the three broad domains of interaction tested in this investigation. In short, even though observations of teacher-student interactions may be somewhat less reliable than desired and may partly reflect attributes of students, they are nonetheless responsive to efforts to induce change, suggesting the relevance of this broad theoretical framework for scientifically-based advances in teacher training and support.

Conclusion

Interactions that students experience in classrooms are the proximal processes that determine the extent to which schooling effectively leads to development and learning, and these results advance an understanding of classroom effects by providing a coherent framework for organizing interactions into three distinct domains. The CLASS Framework serves as a useful heuristic for studying many other significant issues in the field of education related to the antecedents and consequences of emotional, organizational, and instructional interactions in classrooms. For example, future research may help identify characteristics of teachers and classrooms that lead to high quality emotional, organizational and instructional interactions, which may inform pre-service teacher training methods and in-service professional development efforts that produce good teachers. In addition, studies may identify the specific types of classroom interactions that are associated with distinct developmental outcomes, and whether children from different backgrounds are affected differently. Identifying which types of classroom interactions are associated with which developmental outcomes and for whom reflects the sophisticated and nuanced understanding of effective classrooms that is needed to serve the diverse needs of students in America's system of education. And finally, the link between a valid theory and reliable observational assessment of classroom processes holds great promise for alternative education accountability models that not only rely on student outcomes, but also assess and provide objective feedback to teachers that is linked to empirically-based supports that increase the use of effective practices and ultimately improve student learning

References

Ainsworth, M. D., Blehar, M. C., Waters, E., & Wall, D. (1978). *Patterns of attachment: A psychological study of the strange situation*. Hillsdale, NJ: Erlbaum.

Arbuckle, J. L. (1999). *Amos 4.0* [Computer Software]. Chicago: Small Waters.

Arnold, D. H., McWilliams, L., & Arnold, E. H. (1998). Teacher discipline and child misbehavior in day care: untangling causality with correlational data. *Developmental Psychology, 34*, 276-287.

Bentler, P. M., & Bonett, D. G. (1980). Significance tests and goodness-of-fit in the analysis of covariance structures. *Psychological Bulletin, 88*, 588-606.

Birch, S. H., & Ladd, G. W. (1998). Children's interpersonal behaviors and the teacher-child relationship. *Developmental Psychology, 34*, 934-946.

Blair, C. (2002). School readiness: Integrating cognition and emotion in a neurobiological conceptualization of children's functioning at school entry. *American Psychologist, 57*(2), 111-127.

Bogner, K., Raphael, L., & Pressley, M. (2002). How grade 1 teachers motivate literate activity by their students. *Scientific Studies of Reading, 6*(2), 135-165.

Bohn, C. M., Roehrig, A. D., & Pressley, M. (2004). The first days of school in the classrooms of two more effective and four less effective primary-grades teachers. *Elementary School Journal*, *104*(4), 269-287.

Bowlby, J. (1969). *Attachment and loss, vol. 1: Attachment.* New York: Basic Books.

Bowman, B., & Stott, F. (1994). Understanding development in a cultural context: The challenge for teachers. In B. Mallory & R. New (Eds.), *Diversity and developmentally appropriate practices: Challenges for early childhood education* (pp. 19-34). New York, NY: Teachers College Press.

Bransford, J., Brown, A. L., & Cocking, R. R. (Eds.). (1999). *How people learn: Brain, mind, experience, and school*. Washington, DC: National Academy Press.

Breivik, E., & Olsson, U. H. (2001). Adding variables to improve fit: the effect of model size on fit assessment in LISREL. In R. Cudeck, S. du Toit S , D. Sörbom, (Eds.), *Structural Equation Modeling: Present and Future* (pp. 169-194). Ann Arbor, MI: Scientific Software International.

Bronfenbrenner, U., & Morris, P. A. (1998). The ecology of developmental processes. In W. Damon, & R. M. Lerner (Eds.), *Handbook of child psychology: Vol. 1. Theoretical models of human development* (5th edition, pp. 993-1029). New York: John Wiley & Sons.

Brophy, J. (1999). *Teaching.* Educational Practices Series-1. International Academy of Education and International Bureau of Education.

Brophy, J. E., & Good, T. L. (1986). Teacher behavior and student achievement. In M. C. Wittrock (Ed.), *Handbook of research on teaching* (3rd edition, pp. 328-375). New York, NY: Macmillan.

Browne, M. W., & Cudeck, R. (1993). Alternative ways of assessing model fit. In K. A. Bollen & J. S. Long (Eds.), *Testing Structural Equation Models* (pp. 136-162). Newbury Park, CA: Sage.

Bruner, J. (1996). *The culture of education.* Cambridge, MA: Harvard University Press.

Bryant, D., Clifford, R., Early, D., Pianta, R., Howes, C., Barbarin, O., et al. (2002, November). *Findings from the NCEDL multi-state pre-kindergarten study*. Annual meeting of the National Association of the Education of Young Children. New York, NY.

Burchinal, M., Howes, C., Pianta, R., Bryant, D., Early, D., Clifford, R., & Barbarin, O. (2005). *Predicting child outcomes at the end of kindergarten from the quality of pre-kindergarten teaching, instruction, activities, and caregiver sensitivity.* Unpublished manuscript.

Cameron, C. E., Connor, C. M., & Morrison, F. J. (2005). Effects of variation in teacher organization on classroom functioning. *Journal of School Psychology, 43*(1), 61-85.

Carver, S. M. and Klahr D. (Eds.) (2001) *Cognition and instruction: 25 years of progress*. Mahwah , NJ : Erlbaum

Catts, H. W., Fey, M. E., Zhang, X., & Tomblin, J. B. (2001). Language basis of reading and reading disabilities: Evidence from a longitudinal investigation. *Scientific Studies of Reading, 3,* 331-361.

Cochran-Smith, M., & Zeichner, K. (Eds.). (2005). *Studying teacher education: The report of the AERA panel on research and teacher education*. Mahwah, NJ: Lawrence Erlbaum Associates

Connell, J. P., & Wellborn, J. G. (1991). Competence, autonomy, and relatedness: A motivational analysis of self-system processes. In R. Gunnar & L. A. Sroufe (Eds.), *Minnesota Symposia on Child Psychology* (Vol. 23, pp. 43-77). Hillsdale, NJ: Erlbaum.

Davis, E. A., & Miyake, N. (2004). Explorations of scaffolding in complex classroom systems. *Journal of the Learning Sciences, 13*(3), 265-272.

Donovan, M. S. & Bransford, J. D. (2005) *How students learn: History, mathematics, and science in the classroom*. National Academies Press.

Early, D., Barbarin, O., Bryant, D, Burchinal, M., Chang, F., Clifford, R., Crawford, G., Weaver, W, Howes, C. Richie, S. Kraft-Sayre, M., Pianta, R., & Barnett, W. S. (2005). *Prekindergarten in eleven states: NCEDL's multistate study of pre-kindergarten and study of state-wide early education programs (SWEEP).* NCEDL Working Paper. Chapel Hill: The University of North Carolina, FPG Child Development Institute.

Eccles, J. S., & Roeser, R. W. (1999). School and community influences on human development. In M. H. Bornstein & M. E. Lamb (Eds.), *Developmental Psychology: An advanced textbook* (4th Ed.)(pp. 503-554). Mahwah, NJ: Lawrence Erlbaum Associates, Inc.

Emmer, E. T., & Strough, L. (2001). Classroom management: a critical part of educational psychology, with implications for teacher education. *Educational Psychologist, 36*(2)*,* 103–112.

Evertson, C., Emmer, E., Sanford, J., & Clements, B. (1983). Improving classroom management: An experiment in elementary classrooms. *Elementary School Journal*, *84*, 173–188.

Evertson, C., & Harris, A. (1999). Support for managing learning-centered classrooms: The Classroom Organization and Management Program. In H. J. Freiberg (Ed.), *Beyond behaviorism: Changing the classroom management paradigm* (pp. 59–74). Boston: Allyn & Bacon.

Fujiki, M., Brinton, B., & Clarke, D. (2002). Emotion regulation in children with specific language impairment. *Language, Speech, and Hearing Services in Schools, 33*, 102–111.

Gage, F. H. (1978). A multivariate approach to the analysis of social dominance. *Behavioral Biology, 23*, 38–51.

Grolnick, W. S., & Ryan, R. M. (1989). Parent styles associated with children's self-regulation and competence in school. *Journal of Educational Psychology, 81*(2), 143-154.

Hamre, B. K. La Paro, K. M., Locasale-Crouch, J., & Pianta, R. C. (2006). *Children's experiences in kindergarten and stability from the preschool year.* Manuscript submitted for publication.

Hamre, B. K., & Pianta, R. C. (2001). Early teacher-child relationships and the trajectory of children's school outcomes through eighth grade. *Child Development, 72*(2), 625-638.

Hamre, B. K., & Pianta, R. C. (2005). Can instructional and emotional support in the first grade classroom make a difference for children at risk of school failure? *Child Development, 76*(5), 949-967.

Hamre, B. K., & Pianta, R. C. (2007). Learning opportunities in preschool and early elementary classrooms. In R. Pianta, M. Cox, & K. Snow (Eds.), *School readiness & the transition to kindergarten in the era of accountability* (pp. 49-84). Baltimore: Brookes.

Hanushek, E. A. (2002). *The Long Run Importance of School Quality*. NBER Working Papers 9071, National Bureau of Economic Research, Inc.

Harter, S. (1996). Teacher and classmate influences on scholastic motivation, self-esteem, and level of voice in adolescents. In J. Juvonen & K. Wentzel (Eds.), *Social motivation: Understanding children's school adjustment* (pp. 11-42). New York: Cambridge University Press.

Howes, C., Burchinal, M., Pianta, R., Bryant, D., Early, D., Clifford, R., & Barbarin, O. (in press). Ready to learn? Children's pre-academic achievement in pre-kindergarten programs. *Early Childhood Research Quarterly.*

Howes, C., Hamilton, C. E., & Matheson, C. C. (1994). Children's relationships with peers: Differential associations with aspects of the teacher-child relationship. *Child Development, 65,* 253-263.

Hu, L.-T., & Bentler, P. (1995). Evaluating model fit. In R. H. Hoyle (Ed.), *Structural Equation Modeling. Concepts, Issues, and Applications* (pp. 76-99). London: Sage.

Kenny, D. A. & McCoach, D. B. (2003). Effect of the number of variables on measures of fit in Structural Equation Modeling. Structural Equation Modeling, 10, 333-351.

Kline, R.B. (1998). *Principles and practice of structural equation modeling*. New York: Guilford.

Ladd, G. W., Birch, S. H., & Buhs, E. S. (1999). Children's social and scholastic lives in kindergarten: Related spheres of influence? *Child Development, 70,* 1373-1400.

Lynch, M., & Cicchetti, D. (1992). Maltreated children's reports of relatedness to their teachers. In R. C. Pianta (Ed.), *Relationships between children and non-parental adults: New directions in child development* (pp. 81-108). San Francisco: Jossey-Bass.

Mashburn, A. J., Pianta, R. C., Hamre, B. K., Downer, J. T., Barbarin, O., Bryant, D., Burchinal, M., et al. (2007). *Pre-k program standards and children's development of academic and language skills.* Submitted for publication.

Mayer, R. E. (2002). Rote versus meaningful learning. *Theory into practice, 41,* 226-233.

Mulaik, s. A., James, L. R., Van Alstine, J., Benneett, N., Lind, S., & Stilwell, C. D. (1989). Evaluation of goodness-of-fit indices for structural equation models. *Psychological Bulletin, 105,* 430-445.

NICHD Early Child Care Research Network. (2002).The relation of first grade classroom environment to structural classroom features, teacher, and student behaviors. *The Elementary School Journal, 102,* 367-387.

NICHD Early Child Care Research Network. (2003). Social functioning in first grade: Prediction from home, child care and concurrent school experience. *Child Development, 74,* 1639-1662.

NICHD Early Child Care Research Network. (2005). A day in third grade: A large-scale study of classroom quality and teacher and student behavior. *The Elementary School Journal, 105,* 305-323.

No Child Left Behind Act of 2001 [NCLB], H.R. 1, 107th Congress. (2001). www.ed.gov/nclb.

Nye, B., Konstantopoulos, S., & Hedges, L. (2004). How large are teacher effects? *Educational Evaluation and Policy Analysis, 26,* 237-257.

Paris, S. G., & Paris, A. H. (2001). Classroom applications of research on self-regulated learning. Educational Psychologist, 36, 89-101.

Pianta, R. C. (1999). *Enhancing relationships between children and teachers*. Washington, DC: American Psychological Association.

Pianta, R. C., Belsky, J., Houts, R., Morrison, F., & The NICHD Early Child Care Research Network. (2007). Opportunities to learn in America's elementary classrooms. *Science, 315*, 1795-1796.

Pianta, R. C., Belsky, J., Vandergrift, N., Houts, R., Morrison, F., & The NICHD Early Child Care Research Network. (in press). Classroom effects on children's achievement trajectories in elementary school. *American Educational Research Journal.*

Pianta, R. C., Howes, C., Burchinal, M., Bryant, D., Clifford, R., Early, C., et al. (2005). Features of pre-kindergarten programs, classrooms, and teachers: Do they predict observed classroom quality and child-teacher interactions? *Applied Developmental Science, 9*(3), 144-159.

Pianta, R. C., La Paro, K. M., & Hamre, B. K. (in press). *Classroom Assessment Scoring System (CLASS).* Baltimore: Brookes.

Pianta, R. C., Steinberg, M. S., & Rollins, K. B. (1995). The first two years of school: Teacher-child relationships and deflections in children's classroom adjustment. *Development and Psychopathology, 7*, 295-312.

Pressley, M., Allington, R. L., Wharton-McDonald, R., Block, C. C. & Morrow, L. M. (2001). Learning to read: Lessons from exemplary first-grade classrooms. New York: Guilford.

Pressley, M., Roehrig, A., Raphael, L., Dolezal, S., Bohn, C., Mohan, L., Wharton-McDonald, R., Bogner, K., & Hogan, K. (2003). Teaching processes in elementary and secondary education. In W. Reynolds & G. Miller (Eds.), *Handbook of Psychology: Volume 7 Educational Psychology* (pp. 153-176). Hoboken, NJ: John Wiley & Sons, Inc.

Raudenbush, S. W. (2004). *Learning from attempts to improve schooling: The contribution of methodological diversity*. Paper commissioned by the Center for Education of the National Research Council as background for the December 14, 2004 forum, "Applying Multiple Social Science Research Methods to Educational Problems." Unpublished manuscript.

Raver, C. C. (2004). Placing emotional self-regulation in sociocultural and socioeconomic contexts. *Child Development, 75*(2), 346-353.

Rimm-Kaufman, S. E., Early, D. M., & Cox, M. J. (2002). Early behavioral attributes and teachers' sensitivity as predictors of competent behavior in the kindergarten classroom. *Journal of Applied Developmental Psychology, 23*(4), 451-470.

Roeser, R. W., Eccles, J. S., & Sameroff, A. J. (2000). School as a context of early adolescents' academic and social-emotional development: A summary of research findings. *The elementary School Journal, 100,* 443-471.

Rogoff, B. (1990). *Apprenticeship in thinking: Cognitive development in social context.* New York, NY: Oxford University Press.

Romberg, T. A., Carpenter, T. P., & Dremock, F. (2005). *Understanding mathematics and science matters.* Mahwah, NJ: Lawrence Erlbaum Associates.

Rubin, K. H., Coplan, r. J., Fox, N. A., & Calkins, S. D. (1995). Emotionality, emotion regulation, and preschoolers' social adaptation. *Development and Psychopathology, 7,* 49-62.

Ryan, R. M, & Deci, E. L. (2000). Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being. *American Psychologist, 55,* 68-78.

Ryan, R. M. Stiller, J. D., & Lynch, J. H. (1994). Representations of relationships to teachers, parents, and friends as predictors of academic motivation and self-esteem. *Journal of Early Adolescence, 14*(2), 226-249.

Sanders, W. L., & Rivers, J. C. (1996). *Cumulative and residual effects of teachers on future student academic achievement.* Knoxville, TN: University of Tennessee Value-Added Research and Assessment Center.

Shavelson, R. J., Towne, L., & the Committee on Scientific Principles for Education Research (Eds.). (2002). *Scientific Research in Education*. Washington, DC: National Academy Press.

Silver, R. B., Measelle, J., Essex, M., & Armstrong, J. M. (2005). Trajectories of externalizing behavior problems in the classroom: Contributions of child characteristics, family characteristics, and the teacher-child relationship during the school transition. *Journal of School Psychology, 43,* 39-60.

Skibbe, L., Behnke, M., & Justice, L. M. (2004). Parental scaffolding of children's phonological awareness skills: Interactions between mothers and their preschoolers with language difficulties. *Communication Disorders Quarterly, 25*(4), 189-203.

Skinner, E. A., & Belmont, M. J. (1993). Motivation in the classroom: Reciprocal effects of teacher behavior and student engagement across the school year. *Journal of Educational Psychology, 85,* 571-581.

Soar, R., & Soar, R. (1979). Emotional climate and management. In P. Peterson & H. Walberg (Eds.), *Research on teaching: Concepts, findings, and implications* (pp. 97-119). Berkeley, CA: McCutchan.

Tanaka, J. S. (1993). Multifaceted conceptions of fit in structural equation models. In K. S. Bollen & J. S. Long (Eds.), *Testing Structural Equation Models* (pp. 10-39). Newbury Park, CA: Sage.

Taylor, B. M., Pearson, P. D., Peterson, D. S., & Rodriguez, M. C. (2003). Reading growth in high-poverty classrooms: The influence of teacher practices that encourage cognitive engagement in literacy learning. *The Elementary School Journal, 104*, 3-28.

Tobin, R. M., & Graziano, W. G. (2006). Development of regulatory processes through adolescence: A review of recent empirical studies. In D. Mroczek & T. Little (Eds.), Handbook of Personality Development (pp. 263-283). Mahwah, NJ: Erlbaum.

Veenman, M. V. J., Kok, R., & Blöte, A. W. (2005). The relation between intellectual and metacognitive skills in early adolescence. *Instructional Science, 33*(3), 193-211.

Vygotsky, L. S. (1978). *Mind and society: The development of higher mental processes.* Cambridge, MA: Harvard University Press.

Vygotsky, L. S. (1991). Genesis of the higher mental functions. In P. Light, S. Sheldon,& M. Woodhead (Eds.), *Learning to think* (pp. 32-41). Florence, KY: Taylor & Frances/Routledge.

Webster, W. J., & Mendro, R. L. (1997). The Dallas value-added accountability system. In J. Millman (Ed.), *Grading teachers, grading schools: Is student achievement a valid evaluation measure?* (pp. 81-99). Thousand Oaks, CA: Corwin Press.

Wentzel, K. (1998). Social relationships and motivation in middle school: The role of parents, teachers, and peers. *Journal of Educational Psychology, 90*(2), 202-209.

Wharton-McDonald, R., Pressley, M., & Hampston, J. M. (1998). Literacy instruction in nine first-grade classrooms: Teacher characteristics and student achievement. *Elementary School Journal, 99*(2), 101-128.

Williams, W. M., Blythe, T., & White, N. (2002). Practical intelligence for school: Developing metacognitive sources of achievement in adolescence. *Developmental Review, 22*(2), 162-210.

Table 1
Means and Standard Deviations (in parentheses) for Measures of Observed Classroom Interactions

	NCEDL Multi-State Pre-k	SWEEP Pre-k	MTP Pre-k	NCEDL Multi-State KG	NICHD-SECCYD 1st Grade	NICHD-SECCYD 3rd Grade	NICHD-SECCYD 5th Grade	Full Sample
Grade	Pre-K	Pre-K	Pre-K	KG	1st	3rd	5th	Pre-K-5th
Number of Classes Observed	240	454	152	737	834	827	791	4035
Year of Observation	2001-2002	2003-2004	2004-2005	2002-2003	1998	2000	2002	1988-2005
Method of Observations	Live	Live	Video	Live	Live	Live	Live	
Instrument	CLASS	CLASS	CLASS	CLASS	COS-1	COS-3	COS-5	
Emotional Support								
Positive Climate	5.08 (0.83)	5.38 (0.88)	5.03 (0.80)	5.15 (0.75)	5.37 (1.25)	5.07 (0.75)	5.12 (0.68)	5.19 (0.89)
Negative Climate	1.76 (0.65)	1.44 (0.67)	1.48 (0.49)	1.54 (0.65)	1.58 (1.04)	1.17 (0.45)	1.31 (0.50)	1.43 (0.71)
Teacher Sensitivity	4.48 (0.91)	4.82 (0.97)	4.40 (0.77)	4.67 (0.86)	-	4.90 (0.94)	4.84 (0.80)	4.77 (0.89)
Regard for Student Perspectives	-	-	4.40 (0.76)	-	-	-	-	4.40 (0.76)
Classroom Organization								
Behavior Management	4.78 (0.95)	5.07 (0.96)	5.07 (0.81)	5.20 (0.79)	-	-	-	5.09 (0.88)
Instructional Learning Formats	4.10 (0.89)	3.79 (1.23)	4.98 (0.61)	4.12 (0.85)	-	-	-	4.10 (1.01)
Productivity	4.39 (0.87)	4.55 (0.93)	5.67 (0.60)	4.67 (0.74)	-	4.87 (0.98)	4.87 (0.89)	4.78 (0.91)
Classroom Chaos	-	-	-	-	-	1.51 (0.69)	1.40 (0.55)	1.46 (0.63)
Classroom Management	-	-	-	-	5.01 (1.30)	-	-	5.01 (1.30)
Child Responsibility	-	-	-	-	4.25 (1.35)	-	-	4.25 (1.35)
Instructional Support								
Concept Development	2.50 (0.93)	1.87 (0.78)	2.69 (0.57)	2.12 (0.74)	-	-	-	2.16 (0.81)
Quality of Feedback	1.88 (0.75)	2.12 (1.05)	2.87 (0.56)	1.85 (0.64)	3.23 (1.48)	-	3.41 (1.05)	2.68 (1.27)
Language Modeling	-	-	2.90 (0.55)	-	-	-	-	2.90 (0.55)
Instructional Conversation	-	-	-	-	3.12 (1.51)	-	-	3.12 (1.51)
Literacy Instruction	-	-	-	-	5.09 (1.23)	-	-	5.09 (1.23)
Richness of Instructional Methods	-	-	-	-	-	2.11 (0.78)	3.61 (1.06)	2.85 (1.19)

Notes: Values are standardized regression weights. Factor variances were constrained to 1. RMSEA=Root Mean Square Error of Approximation. GFI=Goodness of Fit Index. AGFI=Adjusted Goodness of Fit Index. CFI=Comparative Fit Index. TLI=Tucker-Lewis Index.
*Factor loading was set to 1 so the model was identifiable.

Table 2

CLASS Framework for Early Childhood and Elementary Classroom Quality

Area	Dimension	Description
Emotional Support	Positive Climate	Reflects the overall emotional tone of the classroom and the connection between teachers and students.
	Negative Climate	Reflects overall level of expressed negativity in the classroom between teachers and students (e.g., anger, aggression, irritability).
	Teacher Sensitivity	Encompasses teachers' responsivity to students' needs and awareness of students' level of academic and emotional functioning.
	Regard for Student Perspectives	The degree to which the teacher's interactions with students and classroom activities place an emphasis on students' interests, motivations, and points of view, rather than being very teacher-driven.
Classroom Management	Behavior Management	Encompasses teachers' ability to use effective methods to prevent and redirect misbehavior, by presenting clear behavioral expectations and minimizing time spent on behavioral issues.
	Productivity	Considers how well teachers manage instructional time and routines so that students have the maximum number of opportunity to learn.
	Instructional Learning Formats	The degree to which teachers maximize students' engagement and ability to learn by providing interesting activities, instruction, centers, and materials.
	Classroom Chaos	The degree to which teachers ineffectively manage children in the classroom so that disruption and chaos predominate.
	Classroom Management	The degree to which teachers provide clear instructions, rules, and routines that children clearly know and understand, as well as well-timed proactive behavioral strategies rather than control techniques.
	Child Responsibility	The extent to which teachers provide children with the opportunity to take on roles and operate autonomously in the classroom.
Instructional Support	Concept Development	The degree to which instructional discussions and activities promote students' higher order thinking skills versus focus on rote and fact-based learning.
	Quality of Feedback	Considers teachers' provision of feedback focused on expanding learning and understanding (formative evaluation), not correctness or the end product (summative evaluation).
	Language Modeling	The quality and amount of teachers' use of language-stimulation and language-facilitation techniques during individual, small-group, and large-group interactions with children.
	Instructional Conversation	Considers the extent to which teachers' verbal interactions with children are reciprocal and focus on the facilitation of reasoning, concept development, expression of ideas, and cognitive elaboration.
	Literacy Instruction	The extent to which teachers reads to children, provides explicit phonics instruction, elaborates on books with comprehension and process questions, and exposes children to written language.
	Richness of Instructional Methods	The extent to which teacher use a variety of strategies to promote children's thinking and understanding of material at deeper and more complex level.

Table 3

Results from a Three-Factor Measurement Model of Observed Classroom Interactions

	NCEDL Multi-State Pre-k	SWEEP Pre-k	MTP Pre-k	NCEDL Multi-State KG	NICHD-SECCYD 1st Grade	NICHD-SECCYD 3rd Grade	NICHD-SECCYD 5th Grade
Emotional Support							
Positive Climate	0.93	0.92	0.94	0.94	0.94	0.88	0.80
Negative Climate	-0.69	-0.63	-0.58	-0.67	-0.67	-0.61	-0.58
Teacher Sensitivity	0.96	0.81	0.93	0.95		0.87	0.86
Regard for Student Perspectives			0.85				
Internal consistency (alpha)	*0.89*	*0.83*	*0.89*	*0.79*	*0.77*	*0.80*	*0.78*
Classroom Organization							
Behavior Management	0.82	0.81	0.66	0.81			
Instructional Learning Formats	0.85	0.65	0.89	0.62			
Productivity	0.92	0.87	0.60	0.85		0.87	0.98
Classroom Chaos						-0.62	-0.55
Classroom Management					0.69		
Child Responsibility					0.66		
Internal consistency (alpha)	*0.89*	*0.81*	*0.77*	*0.79*	*0.62*	*0.68*	*0.65*
Instructional Support							
Concept Development	0.92	0.79	0.71	0.86			
Quality of Feedback	0.82	0.93	0.83	0.88	0.69		0.78
Language Modeling			0.81				
Instructional Conversation					0.70		
Literacy Instruction					0.52		
Richness of Instructional Methods						1*	0.82
Internal consistency (alpha)	*0.85*	*0.83*	*0.83*	*0.86*	*0.66*	-	*0.78*
Indices of Fit							
Chi-Square (df)	128.2 (17)	131.8 (17)	120.0(32)	220.5 (17)	63.7 (11)	147.6 (7)	284.4 (11)
RMSEA	0.17	0.12	0.14	0.13	0.08	0.16	0.18
GFI	0.89	0.94	0.86	0.93	0.98	0.95	0.91
CFI	0.93	0.94	0.91	0.95	0.97	0.92	0.88
TLI	0.89	0.91	0.88	0.92	0.94	0.84	0.78

Notes: Values are standardized regression weights. Factor variances were constrained to 1. RMSEA=Root Mean Square Error of Approximation. GFI=Goodness of Fit Index. CFI=Comparative Fit Index. TLI=Tucker-Lewis Index.
*Factor loading was set to 1 so the model was identifiable.

Table 4
Results from a Two-Factor Measurement Model of Observed Classroom Interactions

	NCEDL Multi-State Pre-k	SWEEP Pre-k	MTP Pre-k	NCEDL Multi-State KG	NICHD-SECCYD 1st Grade	NICHD-SECCYD 3rd Grade	NICHD-SECCYD 5th Grade
Emotional/Organization							
Positive Climate	0.92	0.89	0.94	0.93	0.87	0.854	0.78
Negative Climate	-0.70	-0.62	-0.60	-0.67	-0.68	0.62	-0.58
Teacher Sensitivity	0.94	0.80	0.93	0.95		0.86	0.82
Regard for Student Perspectives			0.85				
Behavior Management	0.83	0.77	0.58	0.74			
Productivity	0.80	0.80	0.44	0.76		0.58	0.67
Classroom Chaos						-0.44	-0.47
Classroom Management					0.65		
Child Responsibility					0.60		
Internal consistency (alpha)	*0.92*	*0.88*	*0.87*	*0.91*	*0.79*	*0.81*	*0.80*
Instructional							
Concept Development	0.87	0.80	0.65	0.85			
Quality of Feedback	0.80	0.90	0.78	0.89	0.70		0.81
Language Modeling			0.77				
Instructional Learning Formats	0.76	0.47	0.73	0.53			
Instructional Conversation					0.70		
Literacy Instruction					0.51		
Richness of Instructional Methods						1*	0.79
Internal consistency (alpha)	*0.84*	*0.71*	*0.82*	*0.76*	*0.66*	-	*0.78*
Indices of Fit							
Chi-Square (df)	252.5 (19)	297.8 (19)	195.9 (34)	408.8 (19)	105.8 (13)	302.4 (9)	493.6 (13)
RMSEA	0.23	0.18	0.18	0.17	0.09	0.20	0.22
GFI	0.81	0.87	0.79	0.89	0.96	0.89	0.86
CFI	0.85	0.86	0.84	0.90	0.95	0.84	0.79
TLI	0.79	0.80	0.79	0.86	0.92	0.74	0.67

Notes: Values are standardized regression weights. Factor variances were constrained to 1. RMSEA=Root Mean Square Error of Approximation. GFI=Goodness of Fit Index. CFI=Comparative Fit Index. TLI=Tucker-Lewis Index.
*Factor loading was set to 1 so the model was identifiable.

Table 5

Results from a One-Factor Measurement Model of Observed Classroom Interactions

	NCEDL Multi-State Pre-k	SWEEP Pre-k	MTP Pre-k	NCEDL Multi-State KG	NICHD-SECCYD 1st Grade	NICHD-SECCYD 3rd Grade	NICHD-SECCYD 5th Grade
Positive Climate	0.89	0.86	0.93	0.93	0.83	0.87	0.75
Negative Climate	-0.70	-0.58	-0.59	-0.67	-0.65	-0.62	-0.54
Teacher Sensitivity	0.92	0.77	0.93	0.94		0.86	0.79
Regard for Student Perspectives			0.84				
Behavior Management	0.83	0.79	0.58	0.75			
Instructional Learning Formats	0.78	0.60	0.77	0.55			
Productivity	0.84	0.83	0.46	0.77		0.58	0.71
Classroom Chaos						-0.44	-0.48
Classroom Management					0.67		
Child Responsibility					0.62		
Concept Development	0.60	0.52	0.49	0.37			
Quality of Feedback	0.55	0.60	0.66	0.32	0.53		0.61
Language Modeling			0.66				
Instructional Conversation					0.55		
Literacy Instruction					0.47		
Richness of Instructional Methods						0.38	0.61
Internal consistency (alpha)	*0.92*	*0.88*	*0.91*	*0.88*	*0.81*	*0.79*	*0.82*
Indices of Fit							
Chi-Square (df)	344.6 (20)	457.1 (20)	216.5 (35)	927.2 (20)	217.7 (14)	302.4 (9)	683.6 (14)
RMSEA	0.26	0.22	0.19	0.25	0.13	0.20	0.25
GFI	0.72	0.81	0.77	0.79	0.93	0.89	0.81
CFI	0.80	0.79	0.82	0.77	0.89	0.84	0.71
TLI	0.72	0.70	0.77	0.68	0.83	0.74	0.57

Notes: Values are standardized regression weights. Factor variances were constrained to 1. RMSEA=Root Mean Square Error of Approximation. GFI=Goodness of Fit Index. CFI=Comparative Fit Index. TLI=Tucker-Lewis Index.

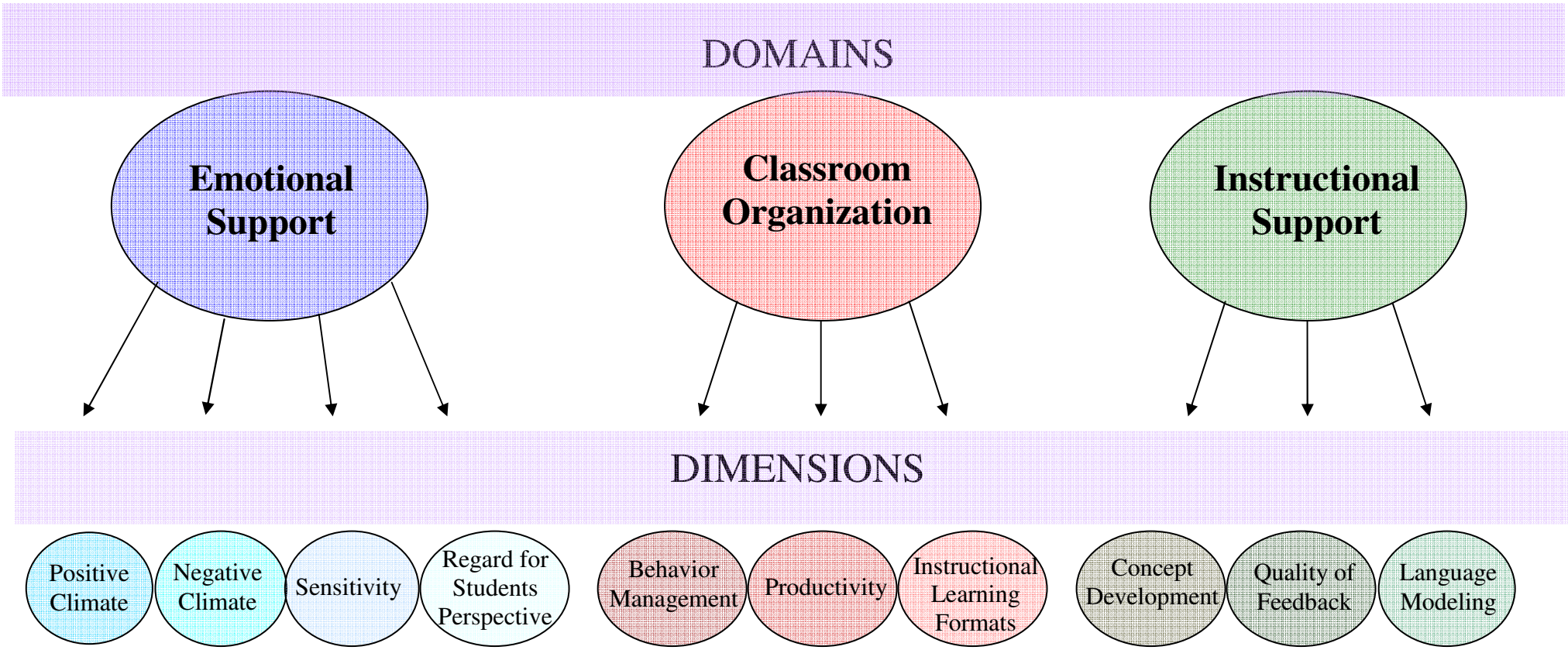

Figure 1. CLASS Framework