The Impact of Teacher Education on Outcomes in Center-Based

Early Childhood Education Programs: A Meta-analysis

Abstract

A key question for early childhood education policy is the extent to which classroom quality could be improved by raising requirements for teacher educational qualifications. Studies generally find a positive relationship between teacher's educational attainment and classroom quality, but conventional reviews do not provide estimates of outcomes that are comparable across studies. This meta-analysis was conducted to provide a quantitative synthesis of research findings on the relationship of teacher educational attainment and measures of classroom quality and child development in center-based early childhood care and education (ECE) settings.

The primary focus of this study was whether completion of a bachelor's degree has a positive impact on ECE outcomes. The analysis indicated that effects on quality outcomes from teachers with a bachelor's degree (the treatment group) were significantly different from those teachers with less education (the comparison group). In standard deviation units, the average effect was .16 standard deviations ($p < .05$) higher for teachers with a bachelor's degree than for their non-bachelor's degree counterparts.

There are, however, two caveats. First, the effect size is relatively small, though significant. Therefore, the benefit of requiring that ECE teachers have a bachelor's degree must be seen in light of the potential benefits of using the requisite funds some other way.

Second, the research underlying this effect size is correlational in nature. Thus, it is possible that any number of factors, aside from having a bachelor's degree, cause this effect.

The Impact of Teacher Education on Outcomes in Center-Based Early Childhood Education Programs: A Meta-analysis

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Introduction

A key question in early childhood care and education (ECE) is the extent to which classroom and student outcomes can be increased by raising teacher education requirements. The current policy debate, framed by state-funded preschool initiatives, is focused on teacher qualifications and in particular, whether or not preschool teachers should have a bachelor's degree. Proponents cite research demonstrating child development outcomes are higher when teachers have bachelor's degrees (Barnett, 2004). Opponents argue that the research relating bachelor's degrees to positive child outcomes is inconclusive, the cost of implementing bachelor's degree requirements is high relative to its benefits, and would result in homogenization of the workforce (Fuller, Livas, & Bridges, 2006). Although some research indicates high quality early education is associated with substantial gains in school readiness and academic achievement, particularly for children from disadvantaged backgrounds (for a review see Shonkoff & Phillips, 2000), evidence for specific effects of teacher educational attainment level on ECE outcomes has been elusive. Accordingly, it is not yet clear whether increasing teacher educational level is related to increases in either classroom quality or student outcomes, and specifically, whether ECE outcomes are greater when teachers have a bachelor's degree compared to teachers with less years of formal education (i.e. within a school setting), including a two-year degree.

A meta-analysis was conducted to fill this gap by synthesizing the research literature on the relationship between teacher educational attainment and measures of process quality and child development in center-based ECE settings. In this study, the question of primary interest is whether higher levels of teacher educational attainment are correlated with higher levels of quality, and in particular, whether ECE outcomes for teachers with a bachelor's degree are larger than those for teachers with less years of education.

Background

There is general agreement among experts in the field of child development that the quality of classroom interactions between teacher and child contributes substantially to children's learning and development (Bowman, Donovan, & Burns, 2001). The quality of teacher-child interactions is primarily determined by the teacher's effectiveness and general behavior in the classroom (Kontos & Wilcox-Herzog, 1997; National Institute of Child Health and Human Development [NICHD] Early Child Care Research Network, 2003; Peisner-Feinberg & Burchinal, 1997; Pianta, 1999). These, in turn, are influenced by work environment and teachers' personal beliefs (Arnett, 1989; McCartney, 1984; NICHD Early Child Care Research Network, 1996; Whitebook, Sakai, Gerber, & Howes, 2001). Classroom effectiveness is associated with teacher's human capital attributes, commonly referred to as teacher quality. Teacher quality has been measured using a number of indicators, including teacher educational attainment. This review will focus on the relationship between teacher educational attainment and measures of classroom quality and child development outcomes in center-based ECE settings.

Compared to the K-12 literature, relatively few studies have focused on the effects of teacher education in early childhood settings. The existing research suggests that in general, higher levels of teacher education are associated with higher overall classroom quality, more positive teacher behaviors in the classroom, and greater gains in cognitive and social development in children (for reviews of this literature see Bowman, et al., 2001; and Whitebook, 2003). However, with respect to the specific levels of education required to produce these outcomes, findings from the existing research are less consistent, as will be seen in the following section.

The Case for Meta-Analysis

A number of empirical studies have been highly influential regarding the effects of teacher education on ECE outcomes, and more specifically, whether or not a bachelor's degree is an important aspect of ECE teacher preparation. A brief sampling of this literature is provided by the following summaries of four well-known studies. As will be seen, methodological variations across the studies make it problematic to draw coherent generalizations. These summaries illustrate the diversity in study characteristics including child samples, research designs, measurement, independent and dependent variables, and modes of analysis.

The National Day Care Study (Ruopp, Travers, Glantz, & Coelen, 1979) was one of the first large-scale investigations to examine teacher qualifications and ECE quality. The study examined the effects of regulated center characteristics (including staff/child ratio, group size and teacher qualifications) on children's classroom behavior, test score gains, and teacher-child interactions. One analysis of child outcomes was conducted on survey data sampled from 49 centers located in three cities. Teacher education was measured as total years of education, and additional teacher qualifications included the presence or absence of specialized (ECE) training, and years of experience. A second analysis involved a sample eight centers from one city, in which children were randomly assigned to classrooms with either low or high staff/child ratios. Classes were taught by teachers with a bachelor's degree or master's degree; diploma from a two-year technical school or at least two years of college; and high school diploma or GED. Child outcomes were measured using scores from several standardized tests and classroom interactions were assessed by direct observation. The results for both studies indicated that teacher education exhibited only weak or inconsistent relationships, with no significant relationship to children's test score gains. However, teachers with specialized training were found to engage in significantly more positive interactions with children, compared to teachers with no training. Also, children taught by teachers with specialized training were rated as more cooperative and involved with tasks and activities than were children in other classrooms. Notably, in centers where all of the teachers had specialized training, children demonstrated an advantage on tests of school readiness skills.

Arnett (1989) conducted an analysis on a small sample of 59 preschool teachers from childcare centers in Bermuda. Teachers had completed either half or the entire two-year ECE training program offered by Bermuda College, had bachelor's degrees in ECE, or had no training. Teacher attitudes and behaviors were assessed using a combination of questionnaires and classroom observations. No significant differences were found between teachers who had completed either half or the entire training program. With respect to classroom behaviors, teachers who had completed half or the entire program were rated higher in positive interactions than teachers with no training, while teachers with a bachelor's degree in ECE received the highest rating of the three groups for positive interactions. Furthermore, teachers who had completed either half or the entire program were rated as less detached and punitive towards children than teachers with no training, while teachers with a BA in ECE were rated as the least detached and punitive. A similar pattern was seen for teacher attitudes.

A large scale study, The National Child Care Staffing Study (NCCSS; Whitebook, Howes, & Phillips, 1990), included 664 classrooms from 227 centers in five large cities obtained by a stratified random sampling procedure. Information on teacher characteristics, including teacher education, was collected through staff interviews. Teacher behavior and classroom process quality were assessed by direct observation, where process quality refers to children's direct experiences in the ECE setting, including their interactions with teachers and peers, and exposure to materials and activities that encourage learning. Results of one analysis indicated that teacher education, measured as total years of education, was positively related to greater sensitivity and more appropriate caregiving in preschool classrooms. The second analysis involved a comparison of four groups of teachers with the following levels of education: high school diploma, some college, associate's degree (AA), and bachelor's degree (BA) or higher. According to the results, teachers with a BA or higher were more sensitive, less harsh, less detached and provided more appropriate caregiving to children than teachers with an AA, some college or a high school diploma. When ECE training was compared across groups, no significant differences were found between teachers with a bachelor's degree and teachers with a BA in ECE; both groups demonstrated greater teaching skills compared to teachers with an AA and teachers with no training. In addition, teachers with college-level training in ECE but no BA demonstrated greater teaching skills compared to teachers with an AA and teachers with no training.

In a more recent study, the NICHD Study of Early Childhood and Duncan (2003) used data collected from a sample of 1300 children in nine states. The study focused on the effects of teacher education (measured as total years of formal education), staff/child ratio, and group size. To test whether program structural quality was related to child cognitive and academic ability, the authors compared three statistical methods, adjusted for family selection bias. The methods included: multiple regression models of 54-month child outcomes, longitudinal models of 24- and 54-month child outcomes, and residualized change models of 54-month child outcomes adjusting for the 24-month outcomes. Structural quality was found to predict cognitive outcomes at 54 months. More specifically, teacher education demonstrated consistent, positive associations with children's 54-month achievement outcomes, including math and reading skills, and phonological knowledge. Of the three indicators of quality (teacher education, staff/child ratio, and group size), teacher education showed the strongest associations with children's achievement outcomes.

Overall, these studies appear to provide some support for the hypothesis that teachers with more education are more skilled at creating high quality learning environments than teachers with less education. However, this picture is clouded by several kinds of methodological variation. There are large and small studies, sampling designs differ, and some analyses are correlational while others are comparative. Constructs such as training and education may vary in meaning across studies. Moreover, some authors rely on significance tests to formulate conclusions while others focus on more practical interpretations of effect (e.g., raw point gains). These sources of variation limit more precise conclusions regarding the exact amount of education required to produce these effects or under what conditions. Without using a more systematic approach, it would be difficult to argue that the current research base provides sufficient guidance for stakeholders seeking to improve ECE programs. Given the panoply of results above, meta-analysis would seem to be the appropriate tool for synthesizing the literature for several reasons: definitions of treatment conditions can be standardized across studies; outcome measures can be collected into similar groupings; study contexts can be taken into account; and a common measure of study outcome can be pooled across studies to obtain a more precise quantitative estimate of impact.

Meta-analysis has been used in the past to evaluate other kinds of ECE interventions (Barnett, 1995; Lazar and Darlington, 1982; Casto, G., and Mastropieri, M.A, 1986; McKey, R.H.; Condelli, L.; Ganson, H.; Barrett, B.J.; McConkey, C.; and Planz, M.C.,1985), but these assessments have focused on overall program effectiveness rather than on the contribution of specific components contributing to effectiveness, including teacher education. A more relevant attempt at research synthesis was conducted recently by Early et al (2007). A secondary analysis, the study uses seven data sets to examine the relationships between teacher education, classroom quality and child academic achievement. Of the seven studies, two indicated quality was higher when teachers had a bachelor's degree or higher, one indicated quality was lower when teachers had a bachelor's degree or higher, and four studies found no significant association. According to the authors, these findings suggest a weak and inconsistent relationship between teacher education and ECE quality measures. The work of Early et al. is discussed in more detail as it relates to this study in the Additional Studies section. Using a broader range of studies than Early et al., the current study will use meta-analytic techniques to synthesize the research literature on the relationship between teacher educational attainment and measures of process quality and child development in center-based ECE settings.

Methods

Meta-analysis is a technique that permits the quantitative synthesis of results from many individual empirical studies that focus on the same topic (Glass, McGaw, & Smith, 1981). It is particularly useful for drawing conclusions with more confidence when individual primary studies present conflicting findings (Camilli,Vargas, & Yurecko, 2003). In conducting a meta-analysis, treatment and control groups are compared using the effect size measure. In comparative studies, effect size is typically measured as the group difference in standard deviation units. Another common measure of effect size in non-comparative studies is the correlation coefficient for assessing the degree of relationship between a specified dependent variable and independent variables. Combining studies using effect sizes can result in increased sample size, statistical power, and consequently the reliability of findings on treatment effects (Thompson, 1999).

Conducting a meta-analysis has been described as a series of five steps (Cooper & Hedges, 1994) that include problem formulation, literature search, coding studies, computing effect sizes, analyzing the data and interpreting the results. In the following section, each step is described as it pertains to the present study.

Problem formulation

The present study attempted to locate all available empirical literature relevant to teacher education, ECE quality and child outcomes, and to select those studies appropriate for the application of meta-analytic techniques. The problem formulation stage provides a framework for identifying the relevant and irrelevant studies for the review with three main procedures: (a) conceptually and operationally defining the variables of interest; (b) stating the type of relationship of interest; and (c) providing the theoretical, practical, and/or historical context of the problem (Cooper, 2007). For this study, the following research question was asked:

> *When taken as a whole, what does the available research reveal with respect to the influence of teacher educational qualifications on measures of quality and child outcomes in ECE classrooms? Specifically, on average, are classrooms taught by teachers with a bachelor's degree higher in quality compared to classrooms taught by teachers with less education, including those with a two-year degree*

To answer this question, the terms quality and child outcomes were defined using six broad categories, based on the most frequently reported measures in a preliminary review of the literature. Table 1 presents a description of each outcome with examples of commonly-used measures. (See Table 1, p. 51.)

In the literature, there is considerable variation in the conceptualization and terminology regarding teacher qualifications. The operational terms "teacher education," "teacher training" and "teacher experience" frequently appeared synonymously across the universe of studies. Because the focus of this research was teacher formal schooling and degree earned, studies were read to determine these specifications regardless of an individual study's conventions for these terms. Teachers with a bachelor’s degree were a central focus, regardless of the major or area of study. However, no differentiation was made for the field in which the degree was earned except in cases where studies reported the degree was in ECE or a field related to child development. Thus, all teachers with a bachelor’s degree received the same code, and teachers with a bachelor’s degree in ECE or related field received an additional code to indicate this specialization.

Teacher training, including various types of teacher certification, such as the Child Development Associate (CDA) was also coded for each study. However, data limitations involving inconsistencies across the literature in the definition and measurement of certification and training programs prevented meaningful analysis of these variables. Thus, the primary focus of this study is on level of formal schooling.

Literature search

To locate studies for this meta-analysis, a search was conducted using four electronic databases: Educational Resources Information Center (ERIC), Journal Storage Archive (JSTOR), ProQuest, Education Full Text, Dissertation Abstracts and a web search using the Google search engine. These databases provided a universe of studies that included published and unpublished research, such as conference papers, journal articles and other documents. Search keywords included: teacher education, preschool, early education, child care, professional development, quality, qualifications, training, and experience. Bibliographies and review articles were also searched. This initial search produced 198 papers. Selection of the articles suitable for meta-analysis was then guided by the following parameters:

1. Study samples must contain preschool-age (3-5 years of age) children.
2. Studies must use outcome measures related to quality in early childhood education services and/or child development.
3. Studies must focus on variation in teacher education and must involve at least one group of teachers with a bachelor's degree.
4. Studies must use quantitative analysis.
5. Studies must report sufficient statistics to compute effect sizes.
6. Studies must be conducted in the United States (one study from Bermuda was included).

Of the studies produced by the initial search, most were excluded due to lack of sufficient information to compute effect sizes. Also, a number of studies were excluded in order to maintain statistical independence of the data. For example, the literature search produced multiple studies that used the Cost, Quality and Child Outcomes study (Helburn, 1995) data set (e.g. Blau, 2000; Burchinal 2002; Helburn, 1995; Howes, 1997; Phillipsen, 1997). In order to maintain the assumption of independent data, only one set of data points from this data set was represented in the meta-analysis sample. In this particular case, two studies were included (Burchinal, 2002; Phillipsen, 1997) because each measured different outcomes. To preserve the data, these two studies were assigned the same study identification number. Seven studies were excluded to maintain statistical independence, including Blau (2000), and Howes (1997). These two studies and others, including the previously mentioned study by Early et al. (2007) are discussed in the Additional Studies section. The final sample contained 32 studies that met the inclusion criteria.

Coding studies

The next step is to design a coding scheme to record the relevant data from each study. Most meta-analyses include codes for outcome measures, independent variables, sample size, the statistics needed for calculating effect sizes and any additional study characteristics that are hypothesized to influence study outcomes. These additional characteristics are also referred to as "moderator" variables. For this meta- analysis, these variables included. (1) teacher training, (2) program type (e.g. for-profit, nonprofit, Head Start, public school pre-k, religious-affiliated), (3) curriculum type/focus, (4) children's age, (5) children's SES, (6) length of program day, and (7) program geographic location. Unfortunately, a lack of reporting of this information prevented any meaningful analyses using these variables. For example, most studies did not include details related to program curricula, which limited our ability to make a distinction between services that focused on early education versus child care (see Appendix A for reported information on moderator variables).

The 32 studies were of two distinct types. One type allowed the reader to determine results from two or more categories of teacher education (i.e. bachelor's degree, associate's degree, some college, high school). These 18 studies, referred to as comparative studies, presented in a format that allowed for between-group comparisons. The other 14 studies, referred to as correlational studies, did not allow for comparisons across groups or even post-hoc creation of different groups. Instead, they merely reported correlations between teacher education (typically reported in years) and outcomes. Due to the differences in reported information, there were some differences in the coding of the two types of studies. The two groups were analyzed separately. For the comparative studies, dummy codes were developed for the level of teacher education: bachelor's degree (BA), associate's degree (AA), some college (SC), and high school diploma (HS). An additional prefix code of T (treatment) or C (comparison) was added to distinguish the treatment and comparison groups. For any given comparison, an effect size was computed by subtracting the comparison mean from the "treatment" mean. For example, Arnett (1989) compared teachers with a bachelor's degree (TBA) to teachers with some college (CSC) and teachers with high school education (CHS); thus, two effect sizes were computed: TBA v. CSC and TBA v. CHS. That is, a group of teachers with higher education was always compared to a group with lower education. If a study reported information regarding ECE training, including certification (e.g. CDA), a dummy code was assigned for the presence or absence of ECE training in either the treatment or control group. Some studies compared groups that contained more than one degree type (usually due to small sample size). The most frequent examples involved combining teachers with an associate's degree with teachers with some college (but no degree) to form one category (i.e. AA/some college), or combining teachers with an associate's degree with teachers with a high school diploma to form one category (i.e. AA/HS).

Effect size calculations

Gains in measured outcomes (teaching quality, classroom quality or child development) were calculated in effect size units. For comparative studies, effect size was calculated as the mean difference between a treatment group and a comparison group, divided by the pooled standard deviation of the two groups. Treatment groups consisted of teachers with higher levels of education, while comparison groups contained teachers with lower levels. Group labels were taken as nominally indicated in the studies; no attempt was made to reconstitute groups that consisted of mixed degree types. When group means and standard deviations were reported, the Hedges' *d* (Hedges & Olkin, 1985) was used to calculate the effect size for a comparison of a treatment (*t*) group of size n_t to a control (*c*) group of size n_c. This formula is given by

$$ES = c(m)\frac{\bar{X}_t - \bar{X}_c}{s_p}, \qquad (1)$$

where $m = n_t + n_c - 2$, $c(m)$ is Hedges' correction , and the pooled standard deviation is given by

$$s_p = \left(\frac{(n_t - 1)s_t^2 + (n_c - 1)s_c^2}{n_t + n_c - 2}\right)^{1/2}. \qquad (2)$$

The approximate sampling variance of the effect size estimator is

$$var(ES) = \frac{n_t + n_c}{n_t \cdot n_c} + \frac{ES^2}{2(n_t + n_c)}. \qquad (3)$$

When studies failed to report means and standard deviations, the effect size was estimated by transforming reported statistics (e.g., *t*, *F*) using the methods described in Cooper and Hedges (1994). Table 2 presents the average effect size for each treatment-comparison pairing across the

18 comparative studies. Also provided in Table 2, are outcome codes, sample size, study design, unit of analysis codes and total number of effect sizes. (See Table 2, p. 52.)

As noted above, a subset of 14 studies, referred to as correlational studies, used correlational analysis to explore the relationship between level of teacher education and study outcomes. The most common correlation reported was between number of years of education and ratings of classroom quality. Invariably, level of education was treated as a continuous variable, but there was great variation in how the scale was defined. Correlations were transformed into comparative effect sizes when sufficient information was given (e.g., point-biserials were transformed to *ES*). When studies failed to report such information, the Pearson correlation coefficient r was used as the primary effect size measure. Table 3 reports the study characteristics and 45 correlations reported for the 14 studies in which comparative effect sizes could not be computed. (See Table 3, p. 54.)

The Unit column refers to the study unit of analysis (i.e. class, teacher, and child). The Scale column refers to the scale of the variable used to measure teacher education, for example, 0-9 indicates that the study measured teacher education using a nine-level variable. The Scale column also indicates the lowest and highest values of the scale (years of education if the variable was measured as total years), outcome category, average correlation effect size, and total number of effect size correlations by outcome.

Descriptive Results

For the comparative sample, teachers with a bachelor's degree were compared to teachers with a high school degree in 56 of the total 105 comparisons. Thus, teachers with a bachelor's degree versus teachers with high school education was, by far, the most common type of comparison in the sample. Tables 4 and Table 5 present mean effect sizes by outcome for the comparative and correlational studies, respectively. For each group of studies, frequencies and mean effect sizes are given for each of the six outcome variables. Table 4 shows, for the comparative studies, the two most frequently measured outcomes were teacher-child interaction (n = 55), followed by class quality (n = 15). On average, effect sizes were positive across all the outcomes, with the largest effect sizes found for teacher beliefs (M = .77; SE = .10) and the smallest effect sizes found for child social development (M = .17; SE = .06). Table 5 shows, for the correlational studies, the two most frequently measured outcomes were child cognitive development (n = 17) and class quality (n = 11), while the least frequently measured outcomes were child social development (n = 7) and instructional activities (n = 1). On average, effect sizes were positive across all the outcomes, with the largest effect sizes found for class quality (M = .23; SE = .03) and the smallest effect sizes found for child social development (M = .03; SE = .06). (See Tables 4 and 5, pp. 55-56.)

While not a focus of this study, it is possible to describe, if not analyze, differences related to the presence or absence of ECE training, including child development certification, with and without a bachelor's degree in the data set. Figure 2 presents a box plot showing bachelor's degree versus non-bachelor's degree effect sizes with and without ECE training. (See Figure 2, p. 50.)

As Figure 2 shows, the means in the two non-bachelor's degree (labeled Non-BA) groups are almost identical. There is a small difference between the bachelor's degree (BA) with ECE and BA without ECE, but the difference is well within the range of sampling fluctuation. There are two outliers: one outlier in the non-BA with ECE group (Cassidy, et al., 1995) and a one in the BA with ECE group (Arnett, 1989). These two studies contained samples that are among the smallest samples in the literature examined by this meta-analysis. Thus, sample sizes are again consistent with random sampling fluctuation. While one can never demonstrate the null hypothesis this is about as close as one can get with this number of observations. One of several problems with this is that it is unclear whether the lack of effects for ECE training are the result of entirely ineffective training, or, alternatively, whether the variation between studies in the definition of ECE training may somehow be responsible for the lack of difference. Thus, although this incremental difference did not justify the inclusion of ECE training in the multilevel analysis, the variable is discussed here for the sake of completeness, should researchers want to study it further.

To evaluate the quality of studies in the meta-analysis sample, a coding scheme was created based on issues related to study design, controls for selection bias and statistical reporting. Studies were evaluated on the following four criteria: research design (3 = true randomized design, 2 = children assigned to teachers, 1 = no groups were assigned); control covariates (5 = pretest score and additional covariates, 4 = pretest score, 3 = two or more covariates--no pretest scores, 2 = one covariate, 1 = no covariates); matching (3 = groups matched on two or more variables, 2 = groups were matched on one variable, 1 = no matching); reported information for computing effect size (3 = means and standard deviations, 2 = one-step conversion formula, 1 = two or more steps for conversion). To examine the relationships between effect size and the four study quality variables, a correlation analysis was conducted. Two of the four quality indicators demonstrate statistically significant, small to moderate correlations with effect size: number of covariate (r = -.380; p <.01), and effect size information (r = .425; p <.01). This indicates that smaller effect sizes were obtained in studies that included more control variables, and that effect sizes are larger in studies that reported more information with which to calculate effect sizes (e.g. mean, standard deviations). The latter finding may reflect the conservative approach that was taken to compute effect size estimates when studies failed to report means and standard deviations.

Multilevel Analysis

To create the analysis data file, one or more contrasts were created within a study by (1) sorting on the independent variable vector of education level codes (BA, AA, SC, and HS) and dependent variable category codes for both treatment and comparisons groups, and (2) averaging across effect sizes within each dependent variable category. The final data file had one effect size per dependent variable category for each treatment-comparison contrast within study. Multilevel modeling was then used to analyze the relationships between the effects of teacher education and outcomes. The standard approach with Hedges' weights was used (Raudenbush, 1994; Raudenbush & Bryk, 2002). With this approach, two sources of random variation are distinguished: prediction errors ε_{ij} within studies, and components τ_i that vary between studies, where the subscript *i* signifies study, and *j* signifies effect size within study. The model, accordingly, can be written:

$$ES_{ij} = \beta_{0i} + \beta_{1i} X_{1ij} + ... + \beta_{ki} X_{kij} + \varepsilon_{ij} \quad (4)$$

where

$$\beta_{0i} = \beta_0 + \tau_i . \quad (5)$$

In the above specification, an outcome variable of interest is denoted by ES_{ij}. In the model given by (4) and (5), the random components are assumed to be uncorrelated with each other and are typically defined as

$$\varepsilon_{ij} \sim \text{NID}(0, \sigma_{\varepsilon}^2), \text{ and} \quad (6)$$

$$\tau_j \sim \text{NID}(0, \sigma_{\tau}^2). \quad (7)$$

The use of ordinary least squares (OLS) regression results from ignoring the multilevel structure, and may result in biased estimates of the fixed coefficients as well as biased inferential tests (Goldstein, 2003). The full model can be written:

$$ES_{ij} = \beta_{0i} + \beta_{1i} X_{1ij} + \beta_{2i} X_{2ij} + \beta_{3i} X_{3ij} + \beta_{4i} X_{4ij} + \beta_{5i} X_{5ij} + \beta_{6i} X_{6ij} + \beta_{7i} X_{7ij} + \beta_{8i} X_{ij} + \varepsilon_{ij} \quad (8)$$

where

X_1 = treatment group: teachers with a BA (TBA)

X_2 = treatment group: teachers with an AA (TAA)

X_3 = control group: teachers with an AA (CAA)

X_4 = control group: teachers with high school diplomas (CHS)

X_5 = outcome measure: global classroom quality (QUAL)

X_6 = outcome measure: child cognitive development (COG).

X_7 = quality indicator: covariates (COV)

X_8 = quality indicator: effect size information (ESI)

Effect size (*ES*) was entered as the dependent variable, and independent and moderator variables were manually entered in a stepwise fashion.

Independent Variables and Multicollinearity

A preliminary analysis was performed to investigate potential collinearity among the predictor variables. The independent variable codes for the treatment and comparison groups exhibited statistically significant, moderate to high correlations that ranged in magnitude from ($r = -.77$; $p < .01$) to ($r = .45$; $p < .01$). The full set of correlations is given in Table 6. For the most part, the patterns are predictable: more of one type of level of education co-occurs with less of another. For example, treatment groups with BAs could also be quantified as groups without SC (some college). Likewise comparison groups without SC tended to be groups with HS (high school) as the highest degree. Generally speaking, the consequences of multicollinearity are confounded estimates and higher standard errors, which in turn lead to lower levels of statistical significance. In this study, the effects of multicollinearity were reduced by deleting the dummy variable for SC (in both the treatment and comparison groups) from further analysis.

After removing nonsignificant variables (TAA, CAA, CHS, QUAL, COG, COV, ESI), the results for the regression analysis in Table 7 were obtained. (See Table 7, p. 58.)

As shown on the top part of Table 7 (labeled Fixed Effects) a statistically significant treatment slope was found for teachers who have a bachelor's degree (shown by the variable TBA) with a corresponding regression coefficient of b = .153 (p = .001). These findings indicate that, on average, outcomes were approximately .15 standard deviations higher in classrooms taught by teachers with a bachelor's degree compared to classrooms taught by teachers with less than a bachelor's degree. With reference to the study quality indicators, a pattern of nonsignificant results was returned, suggesting that quality is not playing any role that can be detected in the current data set. Turning next to lower part of Table 7 (Random Effects), a significant between-study variance component (labeled Between) was estimated of approximately s^2 = .095 (SE = .045). This estimate suggests that there is residual between-study variation which can not be explained by the coded study characteristics. This finding is not unexpected given the limited and incomplete amount descriptive information provided by the articles reviewed.

Examination of Individual Outcome Variables

In the main analysis reported above, a significant effect size for bachelor's degree vs. non-bachelor's degree ECE teachers emerged. However, the effect size measure was collapsed over a series of dependent variables, possibly obscuring differences among them. There were six types of dependent variables. These were: classroom quality, teacher knowledge and beliefs, child cognitive development, child social development, teacher-child interaction, and instructional activities. For these dependent variables, it was possible in four of the six cases to perform a linear regression analysis to determine whether any of the variables showed significant effect (with only two effect sizes, the variable child cognitive outcomes could not be entered into a regression analysis; and with only three effect sizes, the variable child social outcomes could not be entered into a regression analysis). The regression results indicated that all of the effect sizes were in the predicted direction, but none reached statistical significance. For each of the dependent variables entered into a regression equation, the coefficients associated with teachers with a bachelor's degree were as follows: classroom quality (b = .206; *SE* = .207), teacher knowledge, (b = .298; *SE* = .276); teacher-child interaction (b = .320; *SE* = .261); and classroom activities (b = .261; *SE* = .320).

Analysis of Correlational Studies

Because the correlational studies varied widely in sample size from about 30 to over 900, the decision was made to average the correlations within each study and obtain an unweighted average of the aggregated correlations across studies (weighting effect sizes proportional to n would result in ignoring the smaller studies, but there was little difference between weighted and unweighted analyses). The result over the 14 correlational studies was ($\bar{r} = .223$; $p < .001$) with a range (.03, 37), indicating a small but statistically significant relationship between the two variables. It is important to note that this measure of association cannot be transformed into the effect size metric because the scale used to measure teacher education varied across studies (see Table 5). Thus, a unit of teacher education represents a derivation of these scales and cannot be specifically defined in terms of specific years of education categories. In spite of this measurement limitation, both the magnitude and direction of this result are consistent with the findings of the multilevel analysis.

Additional Studies

As noted previously, the literature search produced a number of studies that used the same data sets. To maintain statistical independence of the data, only one set of data points from each data set was included in the meta-analysis sample. Seven studies were excluded from the meta-analysis sample, based on this criterion. These studies are listed in Table 8. In this section, these studies are briefly reviewed with special attention to the recent study by Early et al. (2007).

Three studies used data from the NICHD Study of Early Child Care (NICHD Early Child Care Research Network, 1999, 2000, 2002), a longitudinal study with a sample of over 1000 children and families from nine states. The data set contains variables related to structural and process features of child care settings, child development outcomes, and family demographics. In the current study, the analyses by NICHD and Duncan (2003) are used because they focus more directly on preschool-aged children. With regard to the other analyses, NICHD (1999) investigated child cognitive, language, and social competence at 24 and 36 months of age when they receive child care that meets professional standards for quality (based on recommendations published by the American Public Health Association and the American Academy of Pediatrics). Meeting the standards for caregiver education and training (education must include some college, and formal, post-high school training, including certification or a college degree in ECE) was appeared to have modest effects on higher school readiness and language comprehension scores and fewer behavior problems at 36 months of age. The goal of the second study (NICHD, 2000) was to identify structural and caregiver characteristics associated with positive caregiving for children ages 15, 24 and 36 months of age. Modest, though significant, positive correlations (ranging from .11 to .19) was found between caregiver education and positive caregiving at all four ages. The third study (NICHD, 2002) used structural equation modeling to examine the relationships between structural and process features of ECE quality and child outcomes, with emphasis on the mediated path from structural features of child care quality through process features to child outcomes. A mediated path was found from caregiver training through quality of nonmaternal caregiving to cognitive competence; however, the effect was again modest.

The original Cost, Quality and Child Outcomes in Child Care Centers study (CQO; Helburn, 1995) included both infant/toddler and preschool classrooms. In the current meta-analysis, the results by Phillipsen et al. (1997) were used because they focused exclusively on preschool classrooms. In the original study, Helburn found classrooms taught by teachers from with a bachelor's degree in ECE or advanced training were significantly higher in process quality than those taught by teachers with certificate training, some college or associate's degree, or teachers with no training and a high school diploma. More specifically, teachers with a bachelor's degree in ECE or advanced training were more sensitive and responsive in their interactions with children than teachers with fewer qualifications. In addition, classrooms with the highest quality scores tended to have the highest child assessment scores, suggesting a link between classroom processes and child development. In a separate analysis, higher quality centers were found to have a higher proportion of staff with at least a bachelor's degree.

Howes (1997) re-analyzed data from the Florida Child Care Quality Improvement Study and the CQO in a study designed to address methodological issues of collinearity between teacher education and training. Using the Florida data, classroom quality and children's activities scores were compared across the following four teacher education groups: high school education plus a few ECE workshop trainings; Child Development Associate credential, some college courses in ECE, and a bachelor's degree (BA) or more advanced degree in ECE. According to the results, a BA in ECE or higher was associated with the most sensitive and responsive teaching skills, however a CDA was also effective with respect to teaching skills that require a positive approach, such as positive management, encouraging children's language activities and peer play; and positive initiations. Effect sizes for teachers with a BA in ECE or higher were relatively strong with regard to responsiveness and sensitivity.

Re-analyzing the CQO data, Howes (1997) compared process quality scores across four teacher groups: high school education plus a few workshop trainings in ECE, some college courses in ECE, associate's degree (AA) in ECE, and a bachelor's degree (BA) in ECE or more advanced degree. The results indicated teachers with a BA in ECE or higher were rated as more sensitive than teachers with an AA in ECE, who were, in turn, rated as more sensitive than teachers with some college courses in ECE or a high school diploma. Teachers with at least an AA were rated as more responsive and less harsh than teachers with fewer qualifications. Also, children scored higher on the PPVT-R when their teachers had at least an AA in ECE, compared to children whose teachers had only a high school diploma. Teachers with a BA were again found to be more responsive and sensitive than teachers with high school diplomas/GED.

Blau (2000) re-analyzed data from the CQO study to examine the effects of structural indicators, including teacher qualifications, on the quality of child care. The study focused on methodological issues related to controlling for unobserved differences across centers that could result in biased estimates of ECE effects. Two approaches for addressing this problem were compared. The first approach, the center fixed-effects model, involved adding a number of variables representing various center characteristics to the regression model. The second approach, zip code fixed effects, involved controlling for center location by including a zip code variable. The center and zip code fixed effects models included controls for family background characteristics. Both models resulted in positive effects for teachers with bachelor's degrees, as compared to high school dropouts, but these effects were nearly identical to those for teachers with high school degrees or some college.

Early et al. (2007) examined the links between teacher education, classroom quality and children's academic skills. The study compared data from seven major studies: Early Head Start

Follow-Up, Head Start Family and Child Experiences Survey (FACES), Georgia Early Childhood Study (GECS), More at Four, National Center for Early Development and Learning (NCEDL), NICHD Study of Early Child Care, Preschool Curriculum Evaluation Research Program. Teacher education was measured as high school degree/GED, AA, BA, and graduate degree. Controls for family background and program location were included when available. The authors report that “the lack of significant findings reflects the current reality in the field” (p. 573) and elsewhere that the effects are “largely null” (p. 575). However, descriptions of the statistical models yielding these results are largely absent from the paper, and until the model specification are subject to additional scrutiny, it may be best to describe their findings as the current state of knowledge rather than the “current reality.”

Indeed, there are several indications in the Early et al. (2007) analyses that the effects of a bachelor’s degree are positive, though relatively small. This result would be wholly consistent with the results of the present study. Specifically, Early et al. estimate 27 effects across seven studies and four instruments, yielding 27 estimated total (one combination did not yield an estimate). Of these 27 effects, 19 were positive and eight were negative. If the control variables used successfully created independence of the results, then under the null hypothesis (no effect) a simple binomial test yields the probability $p = .026$. At the standard $\alpha = .05$, this provides some evidence against the null. Moreover, Early et al. report seven statistically significant effects for teachers with a bachelor’s degree versus teachers with no bachelor’s degree. Of these seven, five favor teachers with a bachelor’s degree. Thus, a pattern of evidence emerges that would lead one to reserve judgment on whether there is a bachelor’s degree effect.

Yet there is one more reservation to be taken into consideration. Early et al. assume that “Policy makers are not in a position to interpret the subtleties of various types of educations and training" (p. 561), implying that the quality of a bachelor's degree is not a policy-relevant variable. Yet quality creeps into many of the analyses considered in this paper through measurement and reporting error. That is, many estimates of the benefits of bachelor's level training are distorted by data collection procedure or lack of adequate reporting. Unfortunately, the effect of these errors is to dilute the statistical estimates. Early et al. do not appear to make this distinction, though they clearly recognize the potential of higher standards in bachelor's degree teacher preparation programs (p. 574). As they note, it is prudent to gather more fine-grained information on skills likely to have the highest impacts. Finally, Early et al. also recognize the limited reach of their four dependent variables with respect to the "needed skills for forming individual relationships that can serve as the base for academic learning" (p. 574).

Discussion

In spite of what is known about the benefits of high quality ECE, especially for disadvantaged children (for a review see Shonkoff & Phillips, 2000), inequalities exist between advantaged and disadvantaged children over access to high quality ECE services. Children whose mothers did not complete high school are half as likely to be in center-based care arrangements as those whose mothers are college educated and a similar gap exists between high and low-income families (Bainbridge, Meyers, Tanako, & Waldfogel, 2005). These inequalities may be exacerbated by increasing demand for services (Magnuson, Ruhm, & Waldfogel, 2005). Concerns that many disadvantaged children are insufficiently prepared to start school have called attention to those features of programs that predict quality and that can be regulated through policy intervention, including teacher education. Some policy experts have questioned whether improvements in the quality of center-based ECE programs can be accomplished by raising teacher qualifications and in particular, college education requirements.

The results of this meta-analysis indicate that outcomes in early childhood classroom are more positive when teachers have higher levels of educational attainment and in particular, a bachelor's degree. Specifically, effects on outcomes for teachers with a bachelor's degree were significantly greater than for teachers with less education. In standard deviation units, the incremental effect of a teacher having bachelor's degree was *ES* = .15. It should be noted that this is likely to be a conservative estimate because some treatment and comparison groups contained some uncontrolled mixing of education levels (for example, combining associate's degrees with high school or some college). Though other studies (e.g., Blau, 2000; Early et al., 2007) reported null effects for teachers with a bachelor's degree an alternative interpretation is that the bachelor's degree effect is small but recognized in a wide assortment of studies. To be sure, the effect seems to be modest, yet it also seems plausible that only teachers with a bachelor's degree from high quality programs can have more than incremental effects with underserved children; in the current study, the few large effects observed were for teachers with a bachelor's degree. As illustrated by the box plot in Figure 2, while the mean or median difference between teachers with a bachelor's degree and teachers with less education is relatively small, only teachers with bachelor's degrees yielded large effect sizes (ES = .80 and greater). (See Figure 2, p. 50.)

This finding, along with the mean differences in effect size, supports the hypothesis that the highest outcomes are associated with teachers who have earned a bachelor's degree. Stronger causal claims are not possible given the nonexperimental nature of the current research literature.

Despite this caveat, the argument that no return is reported in the literature for ECE teachers with a bachelor's degree is clearly without merit.

Currently, only 19 states require pre-k teachers have the same educational qualifications as kindergarten teachers (Barnett, 2004). Thus, when making policy decisions that involve raising teacher educational qualifications to the bachelor's level, there are several issues that must also be considered. First, there are substantial costs involved in hiring only bachelor's level teachers. For example, teacher compensation would need to increase proportionately with increases in teacher education. Teacher salaries and fringe benefits would need to be roughly compatible with those of public school teachers; otherwise an incentive would be created for teachers to leave the preschool labor pool for public school and other fields. Second, a related issue involving the cost of ECE services is the potential for private programs to pass these additional costs on to the consumer, which might result in poorer families choosing informal or lower-quality ECE, thereby increasing the gap between advantaged and disadvantaged children. Importantly, gaps in the research remain. For example, there is a lack of data pertaining to the exact behaviors and developmental approaches towards children that are being implemented in high quality classrooms. This knowledge would be useful in determining the specific skills and combinations of skills that are required to produce the effect sizes associated with teachers who have earned a bachelor's degree. If and when these skills are identified, it can be determined whether they can be transmitted to teachers with or without a bachelor's degree. There were a number of relevant issues this study was unable to address, due to lack of statistical reporting. These include the role of teacher training, class curriculum, issues related to children's age, developmental stage, and socioeconomic status. These variables all have the potential to contribute to outcomes in ECE classrooms.

Future Directions

Studies of teacher qualifications inherently involve comparisons of nonequivalent groups; in this case, random assignment is not possible. Inevitably, this creates some uncertainty in the validity of the comparison. For example, to the degree that a specific curriculum was examined, both treatment and control groups must be assumed to use the same curriculum. Generally, this information could not be determined from the study. However, in this case it could be deemed likely because the teachers being compared were usually selected from the same centers. A number of such issues arose in coding the moderator variables. Prospective controlled studies of the teacher education on ECE outcomes have much potential to remedy the uncertainties of quasi-experimental comparisons. Formal managerial protocols would also be useful to standardize program implementation (but not preclude differentiated instruction). Additional recommendations are offered below to facilitate future research in providing better information to practitioners, and policy makers, and researchers.

Research should provide estimates of the effects of teacher education via effect size rather than correlation. We created separate data sets, one for comparative effect sizes and the other for correlations, based on their incommensurate statistical properties. Both sets of analyses exhibited positive effects for teacher education on student and classroom outcomes. However, for correlational studies the assumption of linearity is problematic for obtaining the relationship between years of education and ECE outcomes due to the dubious proposition that each year of college education yields an equal increase in quality or child outcomes. A further complication is that studies used different scales (not linearly related) for coding identical amounts of education. This limits confidence in the aggregation of the correlational evidence. Beyond supporting the hypothesis of positive association between teacher education and ECE outcomes, the correlation analyses are inadequate as a method for drawing precise conclusions.

More satisfactory results were produced by studies that reported effect size differences between groups of teachers with higher and lower levels of education. Such comparisons results in a more accurate measurement because the specific qualities of the two groups can be coded as moderator variables. However, due to variation across studies in reporting teacher education, training and experience, it was not possible to accurately disaggregate teacher education levels. In spite of this limitation, the results indicated that on average, teachers with bachelor's degrees produce larger effects than teachers with lower levels of education. In the future, research designs should include clearly defined teacher education levels and data pertaining to training, certification and experience should be provided. Most importantly, analytic results should be disaggregated by level of education.

Standards for reporting primary research findings should be implemented. The initial literature search identified 198 studies, most of which were excluded from the final analysis because they did not report sufficient information to calculate effect sizes. Researchers should follow a general organizational format for presenting quantitative research. This basic structure should include explicit sections for design, sample, instrumentation, and statistical analysis. It is particularly important that the results section include descriptive statistics, including means and standard deviations disaggregated for each comparison group. Sample demographics and description information (such as children's age) should also be disaggregated. To facilitate these conventions, graduate education in early childhood education should place more emphasis on the fundamentals of research design and analysis as well as standards for reporting research studies (Thompson, 1999).

Strengthen the peer review process. Insufficient reporting of information regarding data, methods, and outcomes in a publication does not necessarily indicate the research itself is weak in quality. The process of peer review is a traditional safeguard for insuring complete and accurate reporting. The suggestions of the previous paragraph should be of concern to editors and reviewers, who in turn provide guidance to authors regarding journal policies. Improved reporting will enhance contributions to knowledge in the field, and will also make findings more usable to practitioners seeking to design or modify early childhood programming.

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Figure 1. *Comparison of Effect Sizes for Teachers With and Without ECE Training*

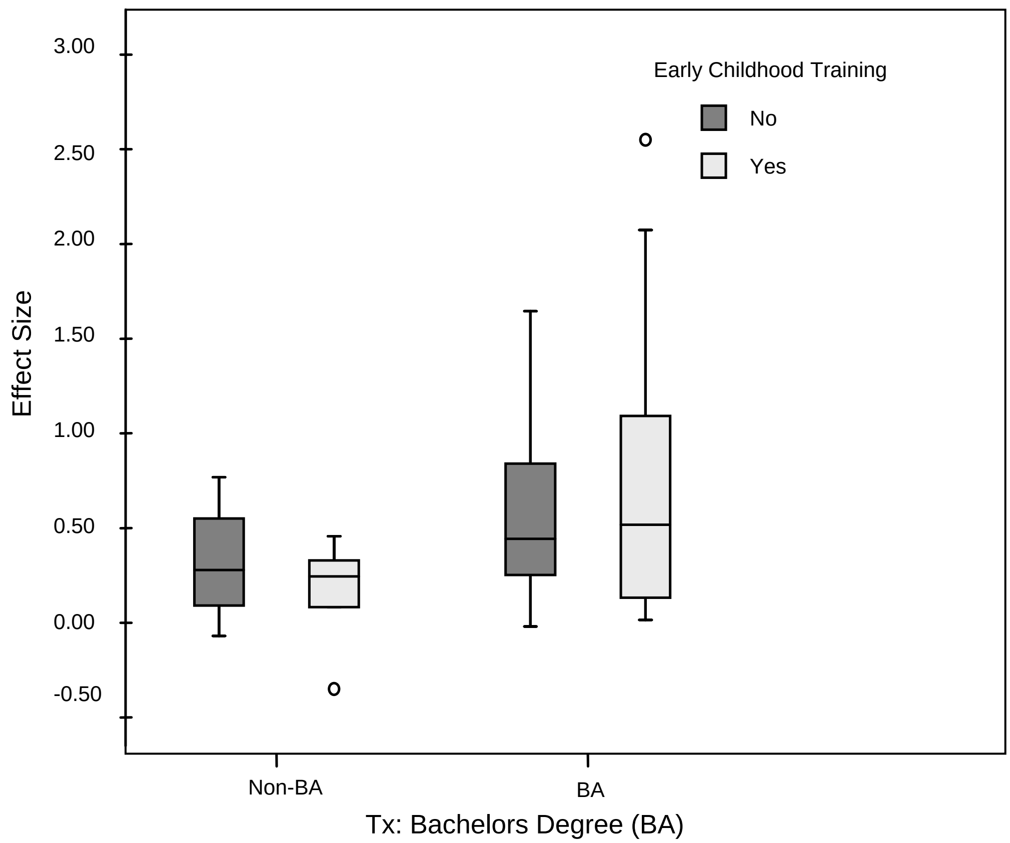

Figure 2.

Box Plot: Comparison of Effect Sizes for Teachers With and Without a BA.

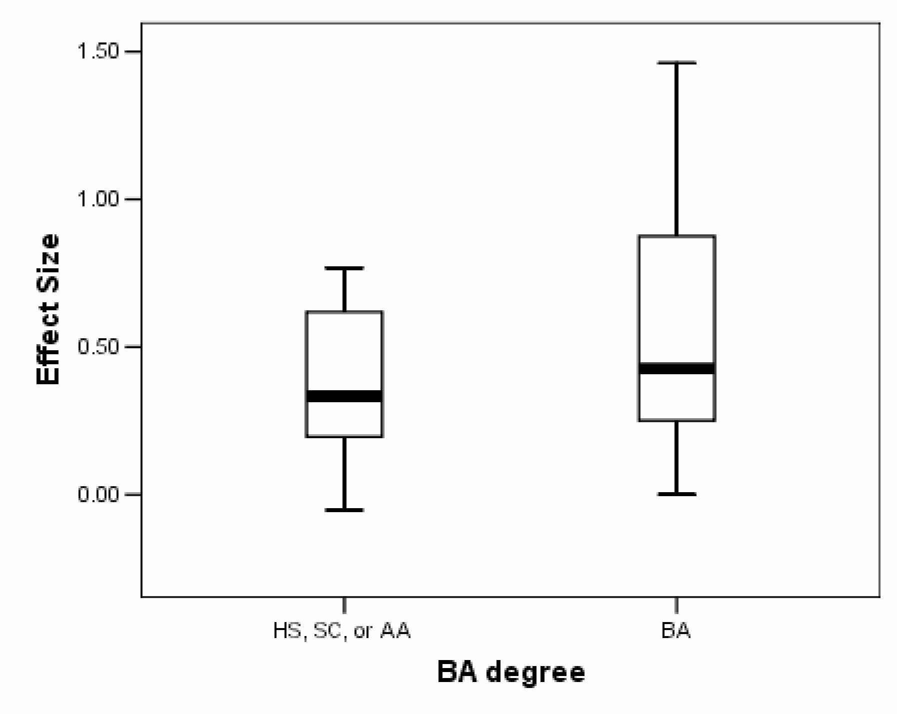

Table 1. ECE Quality and Child Outcome Variables

Variable	Description	Example Measure
ECE Quality:		
Global classroom quality	Overall score that combines classroom experiences across several dimensions, such as interactions with caregivers, age-appropriate materials, & health & safety provisions.	Early Care Environment Rating Scale-Rev. (ECERS-R; Harms, Clifford, & Cryer, 1998).
Teacher pedagogical knowledge and beliefs	Teacher attitudes & perceptions related to ECE.	Teacher Beliefs Scale (Burts, 1991)
Teacher-child interaction	Type & nature of communication between teacher & children.	Arnett Classroom Interaction Scale (Arnett, 1989)
Instructional activities	Teaching vs. other types of interactions Activities that constitute developmentally appropriate vs. inappropriate practices, instructional vs. play-oriented activities, group vs. individual activities, activities that support cognitive & social development, extent to which the activities are organized (Love, Meckstroth, & Sprachman, 1997).	Assessment Profile (Abbott-Shim & Sibley, 1992).
Child Outcomes:		
Cognitive development	How children learn to think, respond, interact with the world. Cognitive & language skills provide foundations of reading & number/math knowledge. Examples: attention, memory, language use, vocabulary, language comprehension, problem solving, reasoning, and strategies for acquiring knowledge (NICHD, 2006).	Peabody Picture Vocabulary Test-Revised (PPVT-R; Dunn & Dunn, 1981)
Social/emotional development	How children interact with adults & peers, ability to manage their own behavior; skills include ability to build & maintain relationships with parents, peers, other adults. Negative social behavior includes impolite assertiveness, non-compliance, aggression, & social withdrawal (NICHD, 2006).	Revised Peer Play Scale (Howes & Matheson, 1992)

Table 2. *Mean Effect Size by Outcome and Treatment-Comparison Group*

Study	Date	*N*	Design[a]	Unit	Outcome[b]	Treatment vs. Comparison	Mean ES	*n*
Arnett	1989	59	A	Teacher	Interaction	TBA vs. CHS	1.18	4
Arnett	1989	59	A	Teacher	Interaction	TBA vs. CSC	1.46	4
Berk	1985	37	B	Teacher	Cog	TBA vs. CHS	0.82	12
Burchinal et al.	2002	273	C	Class	Q	TAA vs. CHS	0.06	1
Burchinal et al.	2002	273	C	Class	Q	TBA vs. CHS	0.46	1
Burchinal et. al.	2002	273	C	Child	Cog	TAA vs. CHS	0.38	1
Burchinal et al.	2002	273	C	Child	Cog	TBA vs. CHS	0.20	1
Burchinal et al.	2002	273	C	Class	Interaction	TAA vs. CHS	0.02	1
Burchinal et al.	2002	273	C	Class	Interaction	TBA vs. CHS	0.33	1
Buysee et al.	1999	180	B	Class	Q	TSC vs. CHS	0.34	2
Buysee et al.	1999	180	B	Class	Q	TBA vs. CHS	0.84	1
Cassidy et al.	1995	41	D	Class	Q	TSC vs. CHS	0.33	1
Cassidy et al.	1995	41	D	Teacher	T	TSC vs. CHS	0.08	1
Cassidy et al.	1995	41	D	Class	Interaction	TSC vs. CHS	0.46	1
Cassidy et al.	1995	41	D	Class	A	TSC vs. CHS	-0.05	2
Etheridge et al.	2002	637	B	Class	Q	TBA vs. CHS	0.87	1
Honig & Hirallal	1998	81	B	Teacher	Interaction	TBA vs.CAA/SC	0.29	2
Honig & Hirallal	1998	81	B	Teacher	Interaction	TBA/AA vs.CSC	0.25	2
Howes et al.	1995	150	E	Class	Q	TBA vs. CHS	1.01	1
Howes et al.	2003	80	B,C	Teacher	Interaction	TBA vs. CAA	0.30	4
Howes et al.	2003	80	B,C	Class	A	TBA vs. CAA	0.37	2
Layzer et al.	1993	119	B	Class	Qual	TBA vs. CHS	0.26	2
Layzer et al.	1993	119	B	Class	Cog	TBA vs. CHS	0.29	1
Layzer et al.	1993	119	B	Class	Social	TBA vs. CHS	0.00	1
Layzer et al.	1993	119	B	Teacher	Interaction	TBA vs. CHS	0.40	8
McMullen	2003	378	B	Teacher	T	TSC vs. CHS	0.59	1
McMullen	2003	378	B	Teacher	A	TSC vs. CHS	0.61	1
McMullen	2003	378	B	Teacher	T	TAA vs. CHS	0.76	1
McMullen	2003	378	B	Teacher	A	TAA vs. CHS	0.60	1

Table 2 *(continued)*

Study	Date	*N*	Design[a]	Unit of Analysis	Outcome[b]	Treatment vs. Comparison	Mean ES	*n*
McMullen	2003	378	B	Teacher	T	TBA vs. CHS	0.93	2
McMullen	2003	378	B	Teacher	A	TBA vs. CHS	0.85	2
McMullen &Alat	2002	58	B	Teacher	T	TBA vs. CAA/HS	0.98	4
Phillipsen et al.	1997	370	C	Class	Q	TSC vs. CHS	0.10	1
Phillipsen et al.	1997	370	C	Class	Interaction	TSC vs. CHS	-0.02	2
Phillipsen et al.	1997	370	C	Class	Q	TBA vs. CHS	0.20	1
Phillipsen et al.	1997	370	C	Class	Interaction	TBA vs. CHS	0.12	2
Snider & Fu	1990	73	B	Teacher	T	TSC vs. CHS	0.68	1
Snider & Fu	1990	73	B	Teacher	T	TBA vs. CHS	0.56	1
Thornberg et al.	2002	110	B	Class	Q	TAA vs. CHS	0.42	1
Thornberg et al.	2002	110	B	Class	Q	BA vs. CHS	0.23	2
Vandell et al.	1988	20	E	Child	Social	TBA vs. CHS	0.21	4
Vandell & Powers	1983	55	E	Child	Social	TBA vs. CHS	0.18	4
Vandell & Powers	1983	55	E	Child	Social	TBA vs. CHS	0.18	4
Whitebook et al.	1989	1201	B	Teacher	Interaction	TSC vs. CHS	0.18	5
Whitebook et al.	1989	1201	B	Teacher	Interaction	TAA vs. CHS	0.27	5
Whitebook et al.	1989	1201	B	Teacher	Interaction	TBA vs. CHS	0.41	5

Note. [a] A = post test only, B = cross sectional survey, C = secondary data analysis, D = pre-post test, E = trend study, F = longitudinal cohort study.[b] Interaction = teacher child interaction, Cog = child cognitive development, Q = classroom quality, T = teacher beliefs, A = instructional activities, Social = child social development.

Table 3. *Correlational Study Characteristics and Effect Sizes*

Author	Year	Unit	*Size*	Scale	Outcome	$\bar{r}$	*n*
Abbott-Shim et al.	2000	Class	190	0-9 (0 = <HS, 9=PhD)	Q	.15	1
ACYF (FACES)	2001	Class	265	Years of Education	Q	.16	1
Barnett et al.	2001	Class	231	1-6 (1=HS, 6=MA)	Q	.34	1
Barnett et al.	2001	Class	231	1-6 (1=HS, 6=MA)	I	.28	2
Barnett et al.	2001	Class	231	1-6 (1=HS, 6=MA)	IA	.22	1
Bryant et al.	1994	Teacher	28	1-5 (1=HS, 5=BA)	Q	.32	1
Burchinal et al.	2000	Class	27	Years of Education	C	.15	11
Clawson	1997	Class	12	Composite Measure	I	.21	1
Epstein	1999	Teacher	366	Years of Education	Q	.11	1
Epstein	1999	Class	366	Years of Education	Q	.15	2
Marshall et al.	2001	Class	88	Years of Education	Q	.26	1
NICHD & Duncan	2003	Child	1327	Years of Education	C	.12	2
Phillips et al.	2000	Class	287	1-9 (1=<HS, 9=PhD)	Q	.30	1
Roach et al.	2001	Teacher	1201	Years of Education	B	.22	3
Scarr et al.	1994	Class	363	1-9 (1=<HS, 9=PhD)	Q	.37	1
Travers et al.	1979	Child	116	Years of Education	C	.13	4
Travers et al.	1979	Child	116	Years of Education	S	.07	7
Whitebook et al.	2001	Child	43	0-1 (0=HS, 1=BA)	Q	.37	1

Note. Q = classroom quality, I = teacher-child interaction, B = teacher beliefs & knowledge, C = child cognitive development, S = child social development, IA = instructional activities

Table 4

Comparative Studies: Mean Effect Size by Study Outcome

Outcome	*n*	*M*	*SE*
Class quality	15	.42	.08
Teacher-child interaction	55	.54	.07
Teacher beliefs	11	.77	.10
Child cognitive	4	.50	.22
Child social	9	.17	.06
Instructional activities	11	.40	.10

Table 5

Correlational Studies: Mean Effect Size by Study Outcome (*n* = 45)

Outcome	*n*	*M*	*SE*
Class quality	11	.23	.03
Teacher-child interaction	9	.21	.01
Teacher beliefs	0	-	-
Child cognitive	17	.14	.03
Child social	7	.03	.06
Instructional activities	1	.22	-

Table 6. *Collinearity (Correlations) Among Teacher Education Predictors*

	1	2	3	4	5	6	7
1. TBA	1.00	-.41**	-.72***	-.14	.25	-.09	-.05
2. TAA	-.41**	1.00	-.14	.45**	-.11	-.01	-.02
3. TSC	-.72***	-.14	1.00	-.12	-.18	.17	-.01
4. CBA	-.14	.45**	-.11	1.00	.01	.13	-.30*
5. CAA	.26	-.11	-.18	.01	1.00	-.14	-.50**
6. CSC	-.09	-.01	.17	.13	-.14	1.00	-.77**
7. CHS	-.05	-.02	.00	-.30*	-.50**	-.77**	1.00

*p<.05, **p<.01, **p<.001

Table 7. *Results from Multilevel Analysis*

Parameter	Source	Estimate	*SE*	df	*t*	*Wald Z*	*Sig*	Lower Bound	Upper Bound
Fixed Effects									
	Intercept	.383	.090	18.15	4.26		.001	.194	.572
	TBA (vs. non-BA)	.152	.043	29.88	3.58		.001	.065	.239
Random Effects	Error[a]	1.217	.325			3.741	.000		
	Between[b]	.095	.045			2.099	.009		

[a] Within-group variance component
[b] Between-group variance component

Table 8. *Additional Studies: Multiple Studies Using Same Data Set*

Data	Author	Year	Reference
CQO	Blau	2000	The production of quality in child care centers: Another look. *Applied Developmental Science, 4*, 136-148.
	Helburn	1995	*Cost, quality and child outcomes in child care centers. Technical report*. Denver: University of Colorado at Denver, Department of Economics, Center for Research in Economic and Social Policy.
CQO, FLA	Howes	1997	Children's experiences in center-based child care as a function of teacher background and adult-child ratio. *Merrill-Palmer Quarterly, 43*, 404-425.
NICHD	NICHD	1999	Child outcomes when child-care center class meet recommended standards for quality. *American Journal of Public Health, 89*, 1072-1077.
	NICHD	2000	Characteristics and quality of child care for toddlers and preschoolers. *Applied Developmental Science, 4*, 116-135.
	NICHD	2002	Child-care structure process outcome: Direct and indirect effects of child-care quality on young children's development. *Psychological Science, 13*, 199-206.
NICHD, FACES	Early et al.	2007	Teachers' education, classroom quality, and young children's academic skills: Results from seven studies of preschool programs. *Child Development*, 2007.