



Child-centered versus teacher-directed teaching practices: Associations with the development of academic skills in the first grade at school



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ABSTRACT

This study examined the extent to which child-centered versus teacher-directed teaching practices predicted the development of children's reading and math skills in the first year of elementary school. In addition, we investigated whether associations between teaching practices and children's academic skills development in Grade 1 differed among children who had low, average, or high initial academic skills at the beginning of school. The reading and math skills of 1,132 Finnish children from 93 classrooms were assessed at the beginning and end of Grade 1, and the Early Childhood Classroom Observation Measure (ECCOM) was used to observe teaching practices in 29 classrooms. The results of multilevel modeling showed, first, that better reading skills upon entering school were associated with a higher level of child-centered teaching practices in the classroom. Second, a high level of child-centered teaching practices predicted children's reading and math skills development during the first school year. Third, the results showed that child-centered teaching practices were equally beneficial for the academic skills development of children with varying initial skill levels. However, teacher-directed practices were found to be negatively associated with reading skills development, particularly among children who had average or high initial reading skills at the beginning of school. The results emphasize the importance of child-centered teacher practices in promoting children's academic skills development also after kindergarten in elementary school.

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1. Introduction

A considerable body of literature indicates that early childhood education (ECE) classroom practices impact child outcomes (Burchinal et al., 2008; Burchinal, Peisner-Feinberg, Pianta, & Howes, 2002). The majority of this research has been conducted in preschools and kindergartens, but only a few studies have focused on the first school year in depth. For example, a wide range of documentation exists on the positive relationship between child-centered teaching practices and children's social skills and academic pre-skills at the preschool age (Stipek, Feiler, Daniels,

& Milburn, 1995). However, children with poor academic skills seem to benefit from teacher-directed practices later on in kindergarten (Huffman & Speer, 2000) and at school age (Kikas, Peets, & Hodges, 2014). The present study examined the extent to which child-centered and teacher-directed teaching practices contribute to the development of Finnish children's reading and math skills during their first school year at age 7, while controlling for the children's initial skill level, parental education, and class size. '

2. Child-centered versus teacher-directed teaching practices

ECE literature, in particular, has focused on child-centered and teacher-directed practices when analyzing the effects of instructional approaches on children's literacy and math skills development (de Botton, 2010; National Association for the Education of Young Children [NAEYC], 2009). The child-centered approach to instruction is close to constructivist theory, whereby

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children are viewed as active constructors of knowledge and the teachers' role is mainly to facilitate their learning in the classroom; whereas the teacher-directed approach has its roots in traditional learning theory and didactics, which holds that basic academic skills are acquired through direct instruction and practice (Daniels & Shumow, 2003; Stipek & Byler, 2004). The practices are unlike in the amount and type of teacher instruction, management practices, and the level of socio-emotional support available in the classroom. The approaches differ to the degree by which the teacher facilitates learning by encouraging children's active exploration and construction of their own knowledge, by including children in various discipline-related decision processes, and by scaffolding to create a positive social climate via individual support and encouragement of peer interactions in the classroom.

Child-centered practices adhere to the principles and professional guidelines of 'developmentally appropriate practices' (DAP; NAEYC, 2009). In child-centered classrooms, teachers assist and facilitate children's learning by providing them with guidance, opportunities, and encouragement to direct their own exploration of objects and academic topics, making teaching akin to a partnership between the teacher and the children (see meta-analysis by Cornelius-White, 2007). Child-centered practices are also characterized by active teacher support for the children's learning efforts and social skills, and teaching practices that are sensitive to children's needs and interests (Paris & Lung, 2008; Stipek & Byler, 2004). Child-centered practices are assumed to be beneficial for children's learning, for example, according to self-determination theory (SDT; Deci & Ryan, 2000), which proposes that when teachers are responsive to children's needs, take into account children's interests, and promote children's autonomy in the classroom, they foster children's motivation to learn, thereby resulting in better learning outcomes.

Conversely, teacher-directed practices are typically characterized by emphasis on the provision of information, and the employment of structured group lessons (relying on oral recitation and worksheets), teaching discrete skills in small steps (c.f., drill and practice), and giving praise to children when predetermined goals are reached (Schweinhart & Weikart, 1988; Stipek, 2004). In teacher-directed practices, less emphasis is typically given to children's own interests and ideas. In addition, children's social skills development or the utilization of peer interactions for learning are not emphasized as much as the systematic teaching and acquisition of the content and basic skills (Stipek & Byler, 2004).

3. Teaching practices and academic outcomes

The first school years have long-lasting effects on children's subsequent achievement (Entwisle & Alexander, 1998; Jimerson, Egeland, & Teo, 1999). Thus, investigating the factors that promote successful development is of great importance. Reading and math are basic skills that children should acquire during the early school years. The developments of these skills have been shown to reveal substantial inter-individual differences over the early school years, as well as high inter-individual stability (Crosnoe et al., 2010; Parrila, Aunola, Kirby, Leskinen, & Nurmi, 2005). For example, Leppänen, Niemi, Aunola and Nurmi (2004) and Parrila et al. (2005) showed high stability in reading performance: Children who had manifested a higher level of reading performance in the beginning of Grade 1 also outperformed other children at the end of the school year. Moreover, the results for math skills (Aunola, Leskinen, Lerkkanen, & Nurmi, 2004; Crosnoe et al., 2010) have shown that children who enter school with high level skills continue to perform more highly than children who enter school with lower levels of skills.

However, previous research has shown that the benefits of different teaching practices can vary depending on the skill domain and the age of the children. The benefits of child-centered practices for the development of children's academic skills have been documented in various studies. For example, Marcon (1999) found that preschoolers (age four) showed greater mastery of reading and math skills in classrooms where the teaching practices were more often child-centered than teacher-directed. Perry, Donohue, and Weinstein (2007) showed that in classrooms where teachers deployed predominantly child-centered practices, students completed the first grade (age six) with higher levels of reading and math skills. Stipek et al. (1998) reported similar positive effects for child-centered teaching practices during the two years from kindergarten entry to the end of the first school year at the age of 6, while Huffman and Speer (2000) found that although letter-word identification and applied problem-solving skills were better in the kindergarten classrooms with a child-centered emphasis, no differences were found with regard to calculation skills.

Teacher-directed practices, in turn, have been shown to contribute positively to academic skills in the kindergarten and early school years, in particular. For example, the findings by Stipek et al. (1995) indicated that 5-year-old kindergarteners in classrooms that stressed teacher-directed practices and basic skills scored significantly higher in letter knowledge and reading achievement tests. Moreover, instruction with a high teacher-directed emphasis has been found to improve the basic skills development of low-income children and school-age children with learning disabilities (Adams & Carnine, 2003; Lovett, Barron, & Benson, 2003), as well as children with low academic skills or those who have difficulty staying focused in learning situations at Grades 1 and 2 (Kikas et al., 2014). In the present study, we were interested in how child-centered versus teacher-directed teaching practices contribute to the development of reading and math skills during the first school year in the Finnish school context when children are already seven years old.

Recent studies have suggested that the effects of teaching practices on child outcomes may also depend on the child's initial academic skills. For example, Connor, Morrison, and Katch (2004) showed that students who participated in first grade classroom instruction, which was optimally effective by being adapted to the child's initial skill level (i.e., code focus for poor readers versus meaning focus for good readers), demonstrated greater reading growth than students in other classrooms. In another study by Kikas et al. (2014), first and second grade classrooms with a high teacher-directed emphasis were found to be beneficial for students with low initial literacy and math skills. In turn, Crosnoe et al. (2010) showed that initially least-skilled children made the most gains in math skills through fifth grade when enrolled in inference-based instruction and when the teacher-child relationship was warm and supportive (i.e. child-centered practices). Therefore, in the present study, the focus was on the extent to which children's initial reading and math skills upon entering school can predict the teaching practices that teachers deploy in the first school year.

Previous studies have emphasized that children's academic skills influence teaching practices and the choices teachers make in terms of instruction (for a meta-analysis, see Nurmi, 2012). Furthermore, Cameron (2012) presented a transactional model of effective teaching and learning, according to which learning is the result of effective transactions between the teacher and the child. Transactions are seen as effective when the child's attributes and current skill level and the teacher's attributes and instruction (i.e., effective classroom management) are encountered in a specific domain. While a significant number of studies have focused on the influence of teaching practices on child outcomes, empirical studies on the role that children's academic skills play in the teacher's choice of teaching practices in the classroom are scant. A number of studies

have shown that children respond in different ways to the same type of instruction, and that the most gains are made when there is a match between the children's skills and the teaching practices (Connor et al., 2004). Thus, it is essential to take into account children's previous skill levels when investigating the effect of teaching practices on academic skills development. In the present study, we were interested in whether the associations between teaching practices and children's academic skills development differ among children with low, average, or high initial academic skills at the beginning of Grade 1.

4. Gaps in the current literature

Previous research on child-centered versus teacher-directed practices and children's academic skills development is limited in several ways. First, most studies have been conducted in preschool and kindergarten classrooms, and only a few studies have been carried out at the elementary school level. Moreover, relatively little is known about the ways in which teaching practices contribute to the development of children's reading or math skills in various cultural and educational settings. Teaching practices in each context are affected by historical background, educational traditions, the school system, teacher education programs, and the generally accepted curriculum aims for learning at school (Schoorman, Mayer, & Davis, 2007). A comparative study by Lerkkanen, Kikas et al. (2012), for example, showed that Finnish and Estonian teachers stress more child-centered than teacher-directed practices in kindergarten classrooms for 6-year-old children, compared to the United States (US), for example, where children are one year younger in kindergarten, but teaching practices are more teacher-directed and the curriculum is more focused on academic skills and assessments (Stipek & Byler, 2004). Moreover, recent studies have shown that the core curriculum in kindergarten and elementary grades can make a difference (de Botton, 2010), and the outcome of academic skills development in different cultural contexts is affected by the teaching practices. For example, Soodla, Lerkkanen, Kikas, Niemi, and Nurmi (2015) compared the effectiveness of first grade reading instruction in two neighboring countries, Finland and Estonia. They showed that despite the Estonian children clearly having better initial skills, the reading skills across both countries were at the same level by the end of the first grade. This finding indicates that the reading instruction provided during the first grade in Finland may have been more effective than in Estonia. However, studies concerning the effect of different mathematics instructions for young children's math skills development are lacking.

The present study was conducted in Finland where there is a very high-quality educational system. For example, Finland has high performance outcomes across the school years on the international comparative education studies of achievement, such as PISA (Program for International Student Assessment; OECD, 2013). Compared to many other countries, Finland has relatively equitable socio-economic circumstances for families, children start formal school one or two years later (at age 7), and class size is typically relatively small (on average, 18.5 students in Grade 1; OECD, 2011). Moreover, the kindergarten curriculum emphasizes developmentally appropriate practices; for example, more emphasis is placed on children's personal and social development goals and learning through play, rather than the formal teaching of academic skills (Hännikäinen & Rasku-Puttonen, 2010). While in the first school year, the curriculum emphasizes basic academic skills, such as decoding, fluency, comprehension, number knowledge, and arithmetic skills. Although Finnish kindergarten practices are mostly child-centered (Lerkkanen, Kikas et al. 2012), no studies have examined the practices that are evident in the first grade. However, the Finnish national core curriculum has underlined smooth school

transition practices, whereby kindergarten and elementary school teachers are encouraged to jointly compile the local curriculum for 6- to 8-years-olds, in an effort to guarantee a smooth transition for each child.

5. Aims and hypotheses

The first aim was to examine the extent to which children's initial reading and math skills upon entering school predict child-centered versus teacher-directed teaching practices that teachers deploy in Grade 1. It was expected (Hypothesis 1) that teachers would engage more in teacher-directed practices in classrooms with children who had poor initial academic skills (Kikas et al., 2014).

The second aim was to examine the extent to which child-centered and teacher-directed teaching practices predict the development of children's reading and math skills from the fall semester of Grade 1 to the spring semester of Grade 1. Based on earlier literature (Perry et al., 2007; Stipek et al., 1998), we expected that child-centered practices would positively predict children's academic skills development (Hypothesis 2). Because previous findings concerning the contribution of teacher-directed practices on children's academic skills development are less consistent, no hypotheses were set regarding the associations between teacher-directed practices and academic skills development.

The third aim was to investigate whether the associations between teaching practices and children's academic skills development in Grade 1 are different among children who have low, average, or high initial academic skills at the beginning of Grade 1. Based on prior evidence (Adams & Carnine, 2003; Crosnoe et al., 2010; Lovett et al., 2003), we expected that children with poor initial academic skills would benefit more from teacher-directed teaching practices when compared to children with average or high initial skills (Hypothesis 3).

We also controlled for a number of potential confounding background variables. First, since it has been suggested that class size may influence the teacher's choice of instructional practices (e.g., child-centered practices appear to be more prevalent in smaller groups; Copple & Bredekamp, 2009), and a smaller class size may have a positive effect on students' reading and math performance (Blatchford, Bassett, & Brown, 2011), we controlled for the effect of class size in our analyses. Second, since parents' educational qualifications have been shown to be associated with children's reading and math performance (Lewis, 2000; McClelland & Morrison, 2003; Melhuish, 2010), we controlled for the parental educational level. Third, because numerous studies have documented higher levels of reading skills in the early school years among girls than among boys (Logan & Johnson, 2009; Phillips, Norris, Osmond, & Maynard, 2002), we also controlled for the effect of gender in our analyses.

6. Method

6.1. Participants

6.1.1. Children

The present study is part of an extensive age cohort study from kindergarten to Grade 4 during the years 2006–2011 (Lerkkanen et al., 2006). The total number of children comprised 1132 children from 93 classrooms. The children were either seven years of age upon entering school or turned seven during the fall semester of Grade 1 ($M = 85.77$ months old, $SD = 3.44$ months). Ninety-nine percent of the children were Finnish-speaking. Parents were asked to give their written consent for their child's participation in the study. If the child did not have parental consent to participate, the teacher or researcher gave her or him other things to do during the

test situations. However, the students stayed in classrooms during the observation sessions unless parents requested that their child not be present during the observation sessions.

6.1.2. Teachers and classrooms

All teachers ($n=93$) in our sample provided their written consent before the study. Most teachers had at least a Master's degree in Education (see Table 1), and the teachers' teaching experience ranged from less than a year to more than 15 years (Mode = more than 15 years). The participating classrooms were in mainstream schools from two medium-sized towns and one municipality located in Central and Eastern Finland. Special education classrooms were not included in the present analyses. Although most of the classrooms were composed exclusively of Grade 1 students, the age composition was wider in some groups typically involving Grade 1 and Grade 2 students (18 classrooms), especially in small schools located in rural areas where mixed age grouping is rather common because every pupil is guaranteed access to a school within their own catchment area.

A subsample of 29 teachers participated in classroom observations on a voluntary basis. We did not find any significant effects of nesting of classrooms within schools (i.e., interdependency of classrooms from the same school) in regards to parents' socio-economic status, degree of vocational training, and family structure. Since classroom observations are time- and resource-consuming, it would not have been feasible to conduct observations in all classrooms. The assumption of missing-at-random (MAR) was tested in two ways. First, we compared the teachers who participated in observations to those who did not participate in regards to a broad set of background variables. The results showed no statistically significant differences between the two groups of teachers in age, educational background, professional experience, number of students in the classrooms, age of the students, and number of personnel available. Furthermore, no differences were found for teachers' self-reported stress, classroom management strategies, or efficacy beliefs. However, teacher-self-reported affection towards students was slightly higher among the observed teachers ($M=4.34$, $SD=0.41$) than among the teachers who chose not to participate in observations ($M=4.13$, $SD=0.38$, $t(70)=2.16$, $p<.05$). Overall, the observed teachers did not differ considerably from the unobserved teachers.

As a second step, we tested the MAR assumption in regards to the variables of this study, which are reading skills, math skills, parental education, classroom size, gender, and teaching practices. To accomplish this, we conducted Little's tests of Missing-Completely-At-Random (MCAR; Little, 1988). Little's MCAR test indicated that the data were missing completely at random: $\chi^2(43)=56.43$, $p>.05$.

The problem of missing data in level-2 predictors (in our case, observed teaching practices at the class level) has received relatively little attention in prior research (van Buuren, 2010). It has, however, been suggested that removing all the observations in a class when there is missingness in one class level predictor is not only wasteful, but can also lead to selection effects at level 2 (van Buuren, 2010). Two recommended alternative methods to handle missingness are using the full information maximum likelihood (FIML) estimation and multiple imputation (Enders, 2010; Schafer & Graham, 2002). Although researchers have indicated feeling more confident imputing their data, there is still no consensus about the maximum number of missing in multilevel data that can be safely imputed or handled by using FIML (van Buuren, 2010). Previous simulation studies show little change in findings based on MAR assumptions for levels of missing data to 50%, although beyond that level, there might be differences in the estimators using different missing data strategies (Johnson & Young, 2011; van Buuren, 2010). Since the missing data were consistent with the assumption

of MAR in this study, statistical analyses were carried out using the FIML, which allows all available information to be used without imputing data (Muthén & Muthén, 1998–2015). Simulation studies show that FIML provides less-biased regression parameter estimates compared to other missing data procedures (Enders, 2001; Olinsky, Chen, & Harlow, 2003). The results of the study will, thus, be reported for the full sample. However, to ensure that the results would also be similar in the smaller sample, we also carried out some additional analyses using only the subsample of observed teachers. The pattern of the results using this subsample was quite similar to those including the whole sample, although the power to detect significant results somewhat decreased along with the decrease in sample size.

6.2. Procedure

Children's reading and math skills test were administered at the beginning (fall 2007) and at the end (spring 2008) of Grade 1. Also, information of background variables was available for Grade 1. Classroom observations were carried out in the early spring of Grade 1, four weeks before testing the children's academic skills at the end of the first grade.

6.3. Measures

6.3.1. Classroom observations of teaching practices

The Early Childhood Classroom Observation Measure (ECCOM; Stipek & Byler, 2004) was employed to observe the extent to which child-centered and teacher-directed approaches to instruction, management, and social climate were present in the classrooms. The ECCOM has been translated and successfully adapted for use in educational settings in Finland (Lerkkanen, Kikas et al., 2012). In the present study, the ECCOM also shows convergent validity with other observational measures of classroom practices, such as the CLASS (Salminen et al., 2012).

The present analyses utilized the ECCOM ratings on both the Child-Centered practices and Teacher-Directed practices scales. Both of these two main scales were assessed along the following three subscales: (1) Management (4 items: child responsibility, management, choice of activities, discipline strategies); (2) Climate (4 items: support for communication skills, support for interpersonal skills, student engagement, individualization of learning activities); and (3) Instruction (6 items: learning standards, coherence of instructional activities, teaching concepts, instructional conversation, literacy instruction, math instruction). In Appendix A (as an online Supplementary material) has been included a Table A1 with a more extensive description of subscales and items. The 14 items were rated on a 5-point scale for both of the main scales (one code for Child-Centered practices and one code for Teacher-Directed practices for each item), for a total of 28 ratings. The rating scale is based on the percentage of time the described practices were observed on the observation day (1 = the practice was rarely seen, 0–20% of the time; to 5 = the practice predominated, 80–100% of the time). The ECCOM independently assesses the degree to which child-centered and teacher-directed approaches are observed in the classroom. Although to some degree one approach conflicts with the other, so that no classroom is likely to receive an equally high score on both scales, classrooms vary in the degree to which they are dominated by one approach or implement a mix of approaches (Stipek & Byler, 2004). Hence, concerning a specific item (e.g., child responsibility), an observed classroom practice might receive a score of 3 on the Child-Centered scale and a score of 5 on the Teacher-Directed scale. Because the ratings of the scale items forming the Management, Climate, and Instruction subscales correlate highly, Stipek (2004) has calculated a single Child-Centered score (the average of scale items rated on

Table 1
Descriptive statistics of children, family, teacher, and classrooms.

	N	%	M	SD	Min–max
Child characteristics	1132	100			
Boys	579	51			
Girls	553	49			
Age			85.77 months	3.44 months	79–102 months
Parental education	955	100	3.48	1.40	1–6
Basic education	43	5			
Secondary education	250	26			
Vocational college	231	24			
Bachelor's degree	139	15			
Master's degree	222	23			
Higher university degree	70	7			
Family structure	872	100			
two-parent household	603	80			
single-parent families	86	10			
blended families	68	8			
divorced parents and the child had two homes	13	2			
Number of classrooms	93	100			
Class size			16.66	6.25	3–27
Teacher's education	72	100			
Master's degree in Education	66	92			
BA degree in Education	6	8			
Observed teachers	29				
Female	26	90			
Male	3	10			

the Child-Centered dimension) and a single Teacher-Directed score (the average of scale items rated on the Teacher-Directed dimension).

In the present study, the 12 observers, undergraduate and graduate students of education or psychology, were carefully prepared with 10 h of training and three hours of live observation practice over a two-week period. In cases where the ratings by a pair of observers showed a discrepancy of more than 1 point, extra rating practice in a live classroom situation was required and the inter-rater agreement was monitored again after this practice. Extra practice was needed by two pairs of observers. At the end of the training, intraclass correlation coefficients (ICCs; McGraw & Wong, 1996) were used to measure the observers' pairwise inter-rater reliability, which was .81, and subsequently, all observers who had completed the training were allowed to proceed with coding.

Classroom observations included two visits to each classroom, conducted on two different days, approximately one week apart, and by one pair of observers. The dates were negotiated with the class teacher who was asked to select two typical school days including at least one literacy and one math lesson. Each observation session lasted three group lessons (three hours) and began when the school day started (in Finland, the school day in Grade 1 typically begins at 8:00 or 9:00 a.m. and lasts four to five hours). The observation times were consistent across classrooms.

The observers took notes during each observation session. After the observation session, the pair of observers first marked their ratings individually. Next, based on their individual ratings, the observers first compared their ratings, discussed the session, and finally agreed on a consensus rating which was marked on a separate form. Inter-rater reliabilities between the pairs of observers based on the individual ratings were calculated using ICCs, and ranges from .69 to .97 were statistically significant ($p < .001$) for all subscales. The ICCs indicated that the independent ratings of the pairs of coders were very similar.

Next, we calculated the mean scores of the consensus ratings across the items of the three subscales (4 items of Management, 4 items of Climate, and 4 items of Instruction) separately for Child-Centered (14 items) and Teacher-Directed (14 items) practices, and across the two different observation days. Since the ratings on the Management, Climate, and Instruction subscales were highly correlated with each other, we calculated overall mean scores for

Table 2
Descriptive information and reliabilities for ECCOM scales and subscales.

Variable	n	Min	Max	M	SD	Cronbach alpha
Child-centered practices (CC)	29	1.04	4.04	3.08	.76	.94
Management (CC)	29	1.00	4.63	3.27	.88	.89
Climate (CC)	29	1.13	4.38	3.10	.80	.78
Instruction (CC)	29	1.00	4.00	2.94	.81	.87
Teacher-directed practices (TD)	29	1.14	4.96	2.41	.83	.94
Management (TD)	29	1.13	5.00	2.26	.97	.89
Climate (TD)	29	1.00	4.88	2.35	.83	.84
Instruction (TD)	29	1.25	5.00	2.54	.88	.86

Child-Centered and Teacher-Directed practices (Stipek and Byler, 2004; Stipek, 2004). The Cronbach's alpha reliabilities, means, and standard deviations for the ECCOM's scores can be found in Table 2.

6.3.2. Reading skills

A group-administered subtest of the nationally standardized reading test battery (ALLU; Lindeman, 1998) was used to assess word-level reading fluency. In this speed test, a maximum of 80 items can be attempted within a two-minute time limit. Each item contained a picture with four words next to it. The children were asked to read the four (phonologically similar) words and draw a line connecting the picture to the word that matched it semantically. Alternative forms of the subtest were used at the two points: Form B with capital letters in the fall of Grade 1, and Form A with lowercase letters in the late spring of Grade 1. The score used in the analyses was constructed by calculating the number of correct answers (the maximum value was 80). Because of the nature of this speed test, the score reflects both the child's fluency in reading the stimulus words, and his or her accuracy in making the correct choice from among the alternatives. Reliable identification of the differences between the children's rate of reading acquisition in the highly transparent Finnish language requires a timed test as one-fourth of the children learn to decode before entering school and measures of word reading accuracy without a time limit are very close to the ceiling at the end of Grade 1 (Lerkkanen, Rasku-Puttonen, Aunola, & Nurmi, 2004). The Cronbach's alphas were .93 in the fall and .95 in the spring, respectively. Alternate-form reliability between forms A and B was .84. No floor or ceiling effects were detected.

6.3.3. Math skills

Children's arithmetic skills were assessed using the Basic Arithmetic Test (BAT; Aunola & Räsänen, 2007). This timed (three-minute time limit) test contains visually presented addition (14 items, e.g., $2 + 1 = ?$, and $3 + 4 + 6 = ?$) and subtraction (14 items, e.g., $4 - 1 = ?$, and $20 - 2 - 4 = ?$) tasks (total of 28 items). The performance in the test requires both accuracy and speed (automatization of basic calculation routines). This measure has been used in a number of earlier publications (Niemi et al., 2011; Zhang et al., 2014). The score used in the analyses was the total number of correct answers (the maximum value was 28). The Kuder–Richardson reliability coefficient was .96 in the fall and .84 in the spring. No floor or ceiling effects were detected.

6.3.4. Control factors

Information on class size, child's gender (0 = girl, 1 = boy), and the level of parental education was available in Grade 1 (see Table 1). The measure of the highest educational level in the family was used in the analyses. The sample was fairly representative of the Finnish population, although the parents had a somewhat higher level of education than the general population (Statistics Finland, 2007). Although the correlation between parents' level of education is typically high, the mothers' level of education in Finland is typically somewhat higher than the educational level of the fathers: 28.6% of mothers and 26.2% of fathers have a master's or higher university degree.

6.4. Analysis strategy

The present study examined the associations between observed child-centered and teacher-directed teaching practices and children's academic skills, when accounting for a number of control variables (i.e., class size, gender, and level of parental education). The analyses were carried out along the following three steps. First, intraclass correlations (ICCs) were calculated both at the beginning (fall) and at the end of Grade 1 (spring) to determine what proportion of the variance in children's reading and math skills is due to the classroom level (i.e., classroom differences, *between-classroom variation*) and what is due to the individual level (i.e., differences between individual children, *within classroom variation*) (Heck & Thomas, 2009; Raudenbush & Bryk, 2002). Statistically significant ICCs mean that the null hypothesis that the mean scores of the academic skills of all classrooms are equal is rejected, and that significant variability in a particular outcome variable exists between classrooms. This is an indication that there is sufficient variability between classrooms to proceed with multilevel modeling (Heck & Thomas, 2009). Second, classroom-level correlations between observed teaching practices and reading and math skills were calculated. Third, separate multilevel path models for the children's reading and math skills were conducted. Since child-centered and teacher-directed teaching practices were highly negatively correlated ($r = -.87, p < .001$), the main analyses were also carried out separately for child-centered and teacher-directed practices.

In the multilevel modeling, teaching practices were treated as classroom-level variables. In turn, children's academic skills at the beginning (fall) and at the end (spring) of Grade 1 were analyzed at both the classroom and individual levels. In other words, academic skills measured at the individual level were allowed to vary between classrooms (cf. random intercepts). Predictor variables were grand-mean centered so that the means of the predictor variables would not impact the intercepts of the dependent variables. Observed teaching practices in the early spring of Grade 1 were predicted by the children's initial academic skills in the beginning of Grade 1 (fall) (Research question [RQ] 1). Furthermore, the children's academic skills at the end of Grade 1 (spring) were predicted by observed teaching practices in early spring, while

controlling for the children's initial academic skills in Grade 1 fall (RQ 2). In addition, cross-level interactions by introducing random slopes were tested to answer the question whether the association between teaching practices and children's academic skills at the end of Grade 1 differs depending on the children's initial academic skills at the beginning of Grade 1 (RQ 3). Class size, child's gender, and the level of parental education were controlled for in all the analyses. Of these control factors, class size was treated as a classroom-level variable. In turn, the parents' educational level (ICC = .08, $p < .01$) was analyzed at both between- and within-levels. The control factor of child's gender was only analyzed at the individual level because of non-significance of the ICC at the classroom level (ICC = .001, $p = .98$).

The analyses were performed using the Mplus statistical package (version 7; Muthén & Muthén, 1998–2015), and the standard MAR approach was applied (Muthén & Muthén, 1998–2015). The parameters of the models were estimated using the FIML estimation with non-normality robust standard errors (MLR estimator; Muthén & Muthén, 1998–2015). The *goodness-of-fit* of the estimated models were evaluated by four indicators: χ^2 -test, Comparative Fit Index (CFI), Root Mean Square Error of Approximation (RMSEA), and Standardized Root Mean Square Residual (SRMR).

7. Results

The results are reported in the following order. First, ICCs (and variance estimates at the between- and within-classroom levels) are presented to indicate what proportion of the total variance in academic skills is due to classroom differences. Second, classroom-level correlations between child-centered and teacher-directed teaching practices and academic skills are reported. Finally, the results of the multilevel path models to investigate associations between observed teaching practices and children's academic skills are presented.

7.1. Intraclass correlations

The results of the ICCs and variance estimates at the between- and within-classroom levels for reading and math skills (see Table 3) showed that differences *between* classrooms were statistically significant: in reading skills 5–7% ($p < .01$) and in math skills 7% ($p < .01$), and 11% ($p < .001$) of the total variance was due to classroom differences. The rest of the variance in academic skills was due to individual differences *within* classrooms. The results indicated that there were statistically significant classroom differences in children's academic skills, which were slightly higher in the spring compared to their scores in the fall. Overall, the results suggested that there was sufficient variability in academic skills at the classroom level to proceed with multilevel path models (Heck & Thomas, 2009).

7.2. Correlations between the teaching practices and academic skills

Next, we calculated the classroom-level correlations between child-centered and teacher-directed practices, and children's reading and math skills. The results showed that child-centered teaching practices were positively associated with both reading ($r = .48, p < .001$) and math skills ($r = .31, p < .05$) typical of the classroom in Grade 1 spring, whereas teacher-directed teaching practices were negatively associated with reading ($r = -.31, p < .05$) and math ($r = -.34, p < .05$) skills typical of the classroom in Grade 1 spring. In addition, child-centered teaching practices were marginally significantly and positively associated with reading skills typical of the classroom in Grade 1 fall ($r = .47, p < .10$). Overall, the associations between the observed teaching practices

Table 3

Descriptive statistics and intraclass correlations (ICCs) for children's reading and math skills at Grade 1, using classroom identification number as a clustering variable ($N_{\text{within}} = 1132$, $N_{\text{between}} = 93$).

Variable	ICC	Between-variance (S.E)	Within-variance (S.E)	Mean	Min.	Max.
Reading skills (fall)	.05**	1.84 (.77)*	38.59 (2.78)***	8.49	0	38
Reading skills (spring)	.07**	5.48 (2.08)**	75.14 (3.73)***	19.15	3	58
Math skills (fall)	.07**	.47 (.15)**	6.25 (.35)***	3.80	0	17
Math skills (spring)	.11***	1.85 (.56)**	15.18 (.73)***	10.75	0	28

Note. *** $p < .001$, ** $p < .01$.

and academic skills were somewhat stronger for reading than math, and stronger for the end of the school year assessment of skills than for the assessment of skills in the beginning of the school year.

7.3. The role of teaching practices on academic skills development

Next, the results for our main research questions will be reported. Our hypotheses (H) were: (H1) teachers would engage more in teacher-directed practices in classrooms with children who had poor initial academic skills; (H2) child-centered practices would positively predict children's academic skills development; and (H3) children with poor initial academic skills would benefit more from teacher-directed teaching practices when compared to children with average or high initial skills.

7.3.1. Child-centered teaching practices and academic skills

The results for observed child-centered teaching practices in children's reading skills development are shown in Table 4. Since no evidence of cross-level interactions was found ($p > .05$), this interaction was excluded from the final model. The final model containing only statistically significant paths fit the data well: [$\chi^2(7, N_{\text{within}} = 1132, N_{\text{between}} = 93) = 6.54, p = .48$; CFI = 1.00; RMSEA = 0.00; SRMR_{between} = 0.06, SRMR_{within} = 0.02]. The results showed, first, that initial reading skills typical of the classroom predicted child-centered teaching practices in Grade 1: the better the initial reading skills typical of the classroom in Grade 1 fall, the more child-centered teaching practices the teacher typically deployed in spring of Grade 1 (see RQ1). Second, child-centered teaching practices predicted reading skills development from Grade 1 fall to Grade 1 spring: the more child-centered teaching practices a teacher typically deployed, the more the children's reading skills increased in that particular classroom (see RQ2). Third, the result of non-existent cross-level interactions indicated that the association between child-centered teaching practices and children's reading skills development does not differ according to a child's initial reading skills (see RQ3). In other words, a high level of child-centered teaching was equally beneficial for the reading skills development of children with varying initial reading skills at the beginning of Grade 1.

The results for control variables indicated at the *classroom-level* that the higher the parental educational level typical of the classroom was, the better the children's reading skills in that classroom (*Unstandardized estimate* = 1.04, *s.e.* = 0.35, $p = .003$). In turn, class size predicted child-centered teaching practices: The smaller the class size, the more child-centered teaching practices the teacher typically deployed (*Unstandardized estimate* = -0.07, *s.e.* = 0.02, $p = .01$). Background variables predicted a child's reading skills also at the *individual-level*: the higher the parental educational level, the higher the child's initial reading skills (*Unstandardized estimate* = 0.53, *s.e.* = 0.14, $p < .001$). Girls showed better initial reading skills than boys (*Unstandardized estimate* = -1.59, *s.e.* = 0.37, $p < .001$).

Next, multilevel models for observed child-centered teaching practices and math skills were carried out. The results are shown in Table 4. Since no evidence of cross-level interactions was

found ($p > .05$), this interaction was excluded from the final model. The final model, containing statistically significant paths only, fit the data well: [$\chi^2(6, N_{\text{within}} = 1132, N_{\text{between}} = 93) = 11.09, p = .09$; CFI = 0.99; RMSEA = 0.03; SRMR_{between} = 0.06, SRMR_{within} = 0.03]. The results showed, first, that initial math skills typical of the classroom did not significantly predict child-centered teaching practices in the spring of Grade 1 (see RQ1). In turn, child-centered teaching practices predicted math skills development from Grade 1 fall to Grade 1 spring: the more child-centered teaching practices a teacher typically deployed, the more the children's math skills increased in that particular classroom (see RQ2). Third, the result of non-existent cross-level interactions indicated that the association between child-centered teaching practices and children's math skills development does not differ according to the child's initial reading skills (see RQ3). In other words, a high level of child-centered teaching was equally beneficial for math skills development for children with varying initial math skills at the beginning of Grade 1.

The results for control variables indicated that the higher the parental educational level typical of the classroom, the better the math skills of the children in that classroom (*Unstandardized estimate* = 0.40, *s.e.* = 0.18, $p = .02$). Furthermore, the smaller the class size (*Unstandardized estimate* = -0.06, *s.e.* = 0.02, $p = .02$), the more child-centered teaching practices the teacher typically deployed. Furthermore, the background variables predicted children's math skills also at the *individual level*: Higher parental education predicted higher initial math skills (*Unstandardized estimate* = 0.21, *s.e.* = 0.06, $p < .001$) and boys' initial math skills were somewhat higher than those of girls (*Unstandardized estimate* = 0.34, *s.e.* = 0.15, $p = .03$).

7.3.2. Teacher-directed teaching practices and academic skills

Finally, multilevel models for teacher-directed teaching practices and academic skills were carried out. The results showed, first, that initial reading skills typical of the classroom did not predict teacher-directed practices ($p > .05$) (see RQ1). Second, teacher-directed practices did not have a main effect on children's reading skills development (see RQ2). Third, however, a significant cross-level interaction was detected: *Estimate* = -0.14, *S.E.* = 0.07, $p < .05$ (see RQ3). The follow-up analyses revealed that when children's initial reading skills at the beginning of Grade 1 were poor (below -1 SD), the direction of the effect from teacher-directed teaching practices on children's reading skills development was positive but non-significant (*Standardized β* = .21, $p = .34$). In turn, when children's initial reading skills were average (between -1 SD and +1 SD), teacher-directed teaching practices were marginally significantly and negatively associated with children's reading skills development (*Standardized β* = -.78, $p < .10$). Moreover, when children's initial reading skills were high (above +1 SD), teacher-directed teaching practices had a strong and negative effect on reading skills development (*Standardized β* = -.93, $p < .05$). In other words, teacher-directed teaching practices are detrimental for reading skills development to some extent among children with an average initial level, but particularly among children with a high initial level of reading skills. Otherwise, the results for control variables

Table 4
Unstandardized Estimates (standard errors in parenthesis) of final multilevel path models for observed child-centered teaching practices and children's academic skills.

Multilevel path model for child-centered teaching practices and reading skills		Multilevel path model for child-centered teaching practices and math skills	
Within-level (individual level)	Est (s.e)	Within-level (individual level)	Est (s.e)
Regression coefficients		Regression coefficients	
Regression coefficient from grade 1 fall reading skills to grade 1 spring reading skills	.99(.04)***	Regression coefficient from grade 1 fall math skills to grade 1 spring math skills	.86(.04)***
Residual variances		Residual variances	
Reading skills (grade 1 spring)	27.25(1.97)***	Math skills (grade 1 spring)	10.54(.57)***
R ² _{within} : model explained 50% of individual level variance of grade 1 spring reading skills		R ² _{within} : model explained 30% of individual level variance of grade 1 spring math skills	
Between-level (classroom level)		Between-level (classroom level)	
Intercepts		Intercepts	
Reading skills (grade 1 spring)	19.76(.38)***	Math skills (grade 1 spring)	10.77(.18)***
Child-centered teaching practices	-.21(.19)	Child-centered teaching practices	.08(.12)
Regression coefficients		Regression coefficients	
Regression coefficient from grade 1 fall reading skills to grade 1 spring reading skills	0*	Regression coefficient from grade 1 fall math skills to grade 1 spring math skills	1.23(.30)***
Regression coefficient from child-centered teaching practices to grade 1 spring reading skills	1.20(.62)*	Regression coefficient from child-centered teaching practices to grade 1 spring math skills	.77(.39)*
Regression coefficient from grade 1 fall reading skills to teaching practices	.34(.13)*	Regression coefficient from grade 1 fall math skills to teaching practices	0*
Residual variances		Residual variances	
Reading skills (grade 1 spring)	4.53 (1.32)**	Math skills (grade 1 spring)	.93(.30)**
Child-centered teaching practices	.38(.15)*	Child-centered teaching practices	.48(.13)***
R ² _{between} : model explained 16% of the class level variance in grade 1 spring reading skills, 39% of variance in child-centered teaching practices		R ² _{between} : model explained 53% of the class level variance in grade 1 spring math skills	

Note. 0* fixed to zero; 0 = girl, 1 = boy; *** $p < .001$, ** $p < .01$, * $p < .05$; effects of gender, class size, and parental education were controlled for in the models.

were the same as for child-centered teaching practices, except that class size positively predicted a level of teacher-directed teaching ($p < .05$): the larger the class size, the more teacher-directed teaching practices the teacher typically deployed.

As the last step, a multilevel model for teacher-directed teaching practices and math skills was estimated. The results showed, however, that children's initial math skills in Grade 1 fall did not predict teacher-directed practices in spring of Grade 1 ($p > .05$) (see RQ1). Moreover, the association between teacher-directed teaching practices and the development of children's math skills was not significant ($p > .05$) (see RQ2). Finally, no evidence for cross-level interactions was found ($p > .05$); that is, children's initial math skills did not moderate the association between teacher-directed teaching and math skills development (see RQ3).

8. Discussion

The present study set out to contribute to the literature by investigating the extent to which child-centered versus teacher-directed teaching practices predicted the development of children's reading and math skills in the first year of elementary school in Finland, and whether these associations differed among children who had low, average, or high initial skills at the beginning of school. The results showed, first, that children's higher initial reading skills, at entry to school, were associated with higher levels of child-centered teaching practices in their classroom. Second, a high level of child-centered teaching practices contributed positively to children's reading and math skills development during the first school year, and the effect did not depend on children's initial skills. Third, teacher-directed teaching practices had no effect on academic skills development. However, an emphasis on teacher-directed practices in the classroom was negatively associated with reading skills development among children who had average or high initial reading skills.

8.1. Initial academic skills predicting teaching practices

The first aim was to examine the extent to which children's initial academic skills predict teaching practices at Grade 1. The results were partly contrary to our first hypothesis: Poor initial skills did not predict more teacher-directed practices in the classroom. However, the higher the initial reading skills in the classroom at school entry, the more child-centered teaching practices the teacher typically deployed. This result adds to previous research by showing that teachers adapt their instruction according to the students' skill level in the early school years (Kikas et al., 2014; Pakarinen, Lerkkanen, Poikkeus, Siekkinen, & Nurmi, 2011). A teacher who emphasizes constructivism and child-centered practices in the classroom is a supporter and sensitive facilitator of children's academic skills development and views children as active contributors to their own learning (Woolfolk Hoy & Weinstein, 2011). In child-centered classrooms, teachers provide a wide array of literacy experiences and instructional choices, including phonics-based and meaning-based tasks, to facilitate each child's individual literacy learning based on the previous knowledge and skills the child had when he or she entered the school (Stipek & Byler, 2004). This kind of sensitivity to each child's skills and needs is important in every classroom, but especially in language contexts where the differences in pre-reading skills between children are very high and the learning to decode will happen with most children a few months after entering school (Lerkkanen et al., 2004). This is usually evident in transparent languages. For example, in the context of the highly transparent Finnish language where one-fourth of the children can decode accurately, two-fourths can recognize some words, and the remainders are non-readers when they enter school (Soodla et al., 2015), it is necessary for the teacher to adapt the reading instruction and tailor the program according to each child's initial skill level. In child-centered classrooms, children typically also have more autonomy over their learning, and they can choose activities and texts according to their personal interests, which will keep their motivation high toward reading practices and further foster their reading skills.

In contrast, math skills did not predict teaching practices. This may be due to the fact that, at least in Finland where the teacher's effort is typically placed strongly on language and literacy skills in the first grade, they seem not to adapt their teaching practices in the classroom according to the children's initial math skills. However, a number of studies have shown great differences between initial math skills in school beginners and how these differences between children increase over time (Aunola et al., 2004; Crosnoe et al., 2010). This is a serious message to the elementary school teachers that they also need to be more sensitive to the initial math skills of each child entering school and adapt the instruction on the basis of the children's skills and understanding of math concepts.

8.2. Teaching practices predicting skill development

The second aim of the study was to examine the extent to which teaching practices predicted children's academic skills development during the first school year. In addition, we investigated whether the associations between teaching practices and children's academic skills development differed depending on children's initial skills. The major finding of the present study was that child-centered practices positively predicted children's reading and math skills development. The result is in accordance with our second hypothesis (Perry et al., 2007; Stipek et al., 1998): The more child-centered the teaching practices were, the more the children's academic skills developed in those particular classrooms. The results showed further that the positive effect of child-centered teaching practices did not depend on the children's initial skills at the beginning of school. The results suggest that child-centered teaching practices were equally beneficial for reading and math skills development in Grade 1 of children with varying initial skills.

There are many possible mechanisms that may explain why child-centered teaching practices were positively associated with children's academic skills development. First, in line with self-determination theory (Deci & Ryan, 2000), it can be suggested that when teachers are responsive to children's needs, take into account their skill level and interests, and promote children's autonomy in a classroom, they foster the children's motivation to learn. The children's motivation will then be related to their better skills. Second, Connor et al. (2004) have indicated that most gains in learning are seen when there is a match between the children's skills and the teacher's practices (Cameron, 2012). Accordingly, it can be suggested that child-centered practices, where the teacher's role is an active facilitator of child's learning, are related to better child outcomes (Hamre, 2014). These practices can be seen to satisfy a child's needs for relatedness and competence (Deci & Ryan, 2000) and, therefore, are beneficial for child development.

Most of the previous studies in the preschool and kindergarten context have shown the benefits of child-centered practices for child outcomes. Our results contribute to the literature by showing that child-centered practices are beneficial for academic skills development still in the elementary school context, at least with children aged seven. However, the indicators for the quality of education and effectiveness of the teacher may vary between countries and educational systems. Our results showed the beneficial influence of child-centered practices in Finland, a country with equitable socio-economic circumstances for families, highly educated teachers, and cooperative school transition practices between kindergarten and elementary school teachers in curriculum planning, which might have some effect on the results. However, in light of the results, encouragement, sensitive and flexible instructional activities and tasks connected to a child's previous skills and knowledge, and a supportive social classroom climate seem to be beneficial for academic skills development in the first grade.

The results for teacher-directed teaching practices revealed no main effects on children's reading and math development in

Grade 1. We expected that children with poor initial academic skills would benefit more from didactic-oriented, teacher-directed teaching practices when compared to children with average or high initial skills (Hypothesis 3). On the contrary, our findings indicated that such practices do not optimally support children's reading or math growth in the first grade. Instead, our results suggest that 7-year-old first graders in Finland may not significantly benefit from lessons focusing on discrete skills, mechanic drill-and-practice, emphasis on the correctness of answers, and strict teacher-directed didactic activities. Instead, opportunities to make one's own choices and cooperative activities with one's peer group are more important for motivating practices (Deci & Ryan, 2000; Lerkkanen, Kiuru et al., 2012), which, in turn, will increase children's academic skills (Morgan & Fuchs, 2007).

8.3. Background factors

Several possible confounding variables were controlled in the present study. The results for these background factors showed that class size predicted the extent to which the teachers employed child-centered teaching practices. The smaller the group, the more child-centered teaching practices were observed, and the bigger the group, the more teacher-directed teaching practices took place in the classroom (Coppie & Bredekamp, 2009). According to our findings, opportunities for more individualized and effective teaching practices are higher in smaller groups. For example, Blatchford, Bassett, Goldstein, and Martin (2003) demonstrated that in smaller classes, teachers engage in more individual interactions with students and take more time for individual tutoring which, in turn, supports students' learning.

The results concerning the other background factors showed that the higher the parental education typical of the classroom, the better the academic skills of the children in that particular classroom at the beginning of school. This result is in agreement with previous studies showing that the level of parental education predicts their children's academic performance (McClelland & Morrison, 2003; Melhuish, 2010). Parental education is presumed to be associated with the quality of the home learning environment, as well as parental action and investment in resources that promote the child's development (Guo & Harris, 2000; Sylva, 2010). Our findings suggest that even in an educational system such as Finland's, which highly emphasizes educational equality, there may be some selection effects which lead to differences in the initial skill levels of children in the classroom.

Our findings also indicated that girls performed better than boys in reading at the beginning of the first school year. Previous studies have documented that girls tend to outscore boys in reading performance throughout the school years (Logan & Johnson, 2009; Phillips et al., 2002; Robinson & Lubienski, 2011). Although there is no simple explanation for the gender gap in literacy skills, using PISA data (OECD, 2013), for example, girls score on average higher than boys in reading, and boys have more difficulties and lower interest in reading in every country. We also found boys' initial math skills to be higher than those of girls. One possible explanation for this finding is that boys tend to have a higher level of math-related motivation (Eccles, Wigfield, Harold, & Blumenfeld, 1993; Lerkkanen, Kiuru et al., 2012) and higher competency beliefs in math (Herbert & Stipek, 2005) than girls in the first grade, which might contribute positively to boys' math skills development.

8.4. Practical implications

The debate about whether to use a child-centered or a teacher-directed approach for the effective education of young children is ongoing. In most countries, ECE borrows from both traditions and for example de Botton's (2010) findings suggest that effective early

education programs might emphasize a balance between child-centered and teacher-directed activities. However, the results of the present study showed that child-centered practices are beneficial for children's reading skills despite their initial skill level, suggesting that teachers and teacher training should emphasize the importance of child-centered and adaptive teaching practices in early elementary school. Cameron (2012) has proposed that teaching promotes learning effectively when teacher-child transactions are targeted at the child's current skill level; therefore, teachers should apply their time and effort to observing and assessing each child's individual needs and current skills. Child-centered reading instruction, for example, engages children in meaningful activities and provides a broad range of literacy experiences, including phonics embedded in meaningful text, whole language focusing on understanding, and activities designed to develop language skills and comprehension strategies (Stipek & Byler, 2004).

The results regarding math skills and teaching practices call teachers' attention to the need for better awareness of children's initial math skills to close the gap between poor beginners and other children. Namely, it was found that child-centered practices promoted the development of math skills, but teachers adapted their practices only according to children's initial reading skills. In child-centered math instruction, the teacher is sensitive to child's knowledge and gives children encouragement and guidance to understand mathematical processes by integrating math problems into everyday routines and children's experiences (Stipek & Byler, 2004). To close gaps between children in math skills, we should provide intensive support to teachers to improve their child-centered practices in math lessons, complemented by curriculum materials with suggested activities, lesson plans, and schemes of work linked to specific learning and developmental objectives (de Botton, 2010). Therefore, interventions should be targeted to increase teachers' awareness of the effect of their teaching practices and the benefits of child-centered practices for academic skills development.

8.5. Limitations and direction for future research

Some limitations need to be taken into account with any attempts to generalize the findings of the present study. First, although the missing data concerning classroom observations was large, various simulation studies have shown little change in the findings, based on MAR assumptions, for levels of missing data to 50%; although, beyond that level, there might be differences in the estimators using different missing data strategies (van Buuren, 2010; Johnson & Young, 2011). However, the small sample size of the observed teachers is likely to have diminished the power of our statistical testing. Second, although no differences in background or self-reported teacher variables were found between the teachers who voluntarily participated in the observations and those who did not participate, it might be possible that teachers who chose to participate might still differ in some sense. This needs to be addressed in further studies. Third, the ECCOM may contain a bias towards emphasizing the benefits of child-centered practices on child outcomes, because child-centered practices tend to be operationalized along the lines of a positive emotional climate, whereas characterizations of teacher-directed practices tend to imply a less positive emotional climate. An important future direction would be to employ person-oriented methods (Bergman, Magnusson, & El-Khoury, 2003) to identify subgroups of teachers characterized by different relative levels of child-centered and teacher-directed practices. Fourth, other characteristics of teachers (e.g., teacher experience, teacher beliefs, self-efficacy) and children (e.g., motivation to reading and math), which were not studied in the present study, might be important as well and need to be taken into account in further studies. Moreover, the consistent orthography

of the Finnish language makes the paths of literacy development differently paced than in language contexts of a less consistent orthography and may affect the instructional choices.

9. Conclusions

The results of the present study add to previous research by showing that child-centered teaching practices play an important role in the development of children's academic skills in elementary school. In the first grade classrooms in which the teachers deployed a high degree of child-centered teaching practices, defined as sensitivity to children's interests, scaffolding learning according to individual needs, and creating opportunities for active peer engagement, children showed greater skills development during the academic year than in classrooms characterized by less child-centered teaching practices. Teacher-directed practices were even detrimental for the development of reading skills for those children with high initial skills at entry to school.

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Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at <http://dx.doi.org/10.1016/j.ecresq.2015.12.023>.

References

- Adams, G., & Carnine, D. (2003). Direct instruction. In H. Swanson, H. E. Lee, & K. Harris (Eds.), *Handbook of learning disabilities* (pp. 403–416). New York, NY: Guilford Press.
- Aunola, K., Leskinen, E., Lerkkanen, M.-K., & Nurmi, J.-E. (2004). Developmental dynamics of math performance from preschool to grade 2. *Journal of Educational Psychology*, 96, 699–713. <http://dx.doi.org/10.1037/0022-0663.96.4.699>
- Aunola, K., & Räsänen, P. (2007). *The basic arithmetic test*. Jyväskylä, Finland: Department of Psychology, University of Jyväskylä. Unpublished test
- Bergman, L., Magnusson, D., & El-Khoury, B. M. (2003). *Studying individual development in an interindividual context*. Mahwah, NJ: Erlbaum.
- Blatchford, P., Bassett, P., & Brown, P. (2011). Examining the effect of class size on classroom engagement and teacher-pupil interaction: differences in relation to pupil prior attainment and primary vs. secondary schools. *Learning and Instruction*, 21, 715–730. <http://dx.doi.org/10.1016/j.learninstruc.2011.04.001>
- Blatchford, P., Bassett, P., Goldstein, H., & Martin, C. (2003). Are class size differences related to pupils' educational progress and classroom processes? Findings from the institute of education class size study of children aged 5–7 years. *British Educational Research Journal*, 29, 709–730. <http://dx.doi.org/10.1080/0141192032000133668>
- de Botton, O. (2010). Analysis: teacher-led activities 'produce better results', retrieved from <http://www.nurseryworld.co.uk/nursery-world/news/1095114/analysis-teacher-led-activities-produce-results> (accessed 15.10.15)
- Burchinal, M., Howes, C., Pianta, R. C., Bryant, D., Early, D., Clifford, R., & Barbarin, O. (2008). Predicting child outcomes at the end of kindergarten from the quality of pre-kindergarten teacher-child interactions and instruction. *Applied Developmental Science*, 12, 140–153. <http://dx.doi.org/10.1080/10888690802199418>
- Burchinal, M. R., Peisner-Feinberg, E., Pianta, R. C., & Howes, C. (2002). Development of academic skills from preschool through second grade: family and classroom predictors of developmental trajectories. *Journal of School Psychology*, 40, 415–436. [http://dx.doi.org/10.1016/S0022-4405\(02\)00107-3](http://dx.doi.org/10.1016/S0022-4405(02)00107-3)
- van Buuren, S. (2010). Multiple imputation of multilevel data. In J. J. Hox, & J. K. Roberts (Eds.), *The handbook of advanced multilevel analysis* (pp. 173–196). New York, NY: Roudledge Academic.
- Cameron, C. E. (2012). A transactional model of effective teaching and learning in the early childhood classroom. In R. Pianta (Ed.), *Handbook of early education* (pp. 278–296). New York, NY: Guilford Press.
- Connor, C. M., Morrison, F. J., & Katch, E. L. (2004). Beyond the reading wars: exploring the effect of child-instruction interaction on growth in early

- reading. *Scientific Studies of Reading*, 8, 305–336. <http://dx.doi.org/10.1207/s1532799xssr>
- Copple, C., & Bredekamp, S. (Eds.). (2009). *Developmentally appropriate practice in early childhood programs serving children from birth through age 8*. Washington, DC: National Association for the Education of Young Children.
- Cornelius-White, J. (2007). Learner-centered teacher-student relationships are effective: a meta-analysis. *Review of Educational Research*, 77, 113–143. <http://dx.doi.org/10.3102/003465430298563>
- Crosnoe, R., Morrison, F., Burchinal, M., Pianta, R., Keating, D., Friedman, S. L., & Clarke-Stewart, K. A. (2010). Instruction, teacher-student relations, and math achievement trajectories in elementary school. *Journal of Educational Psychology*, 102, 407–417. <http://dx.doi.org/10.1037/a0017762>
- Daniels, D. H., & Shumow, L. (2003). Child development and classroom teaching: a review of the literature and implications for educating teachers. *Applied Developmental Psychology*, 23, 495–526. [http://dx.doi.org/10.1016/s0193-3973\(02\)00139-9](http://dx.doi.org/10.1016/s0193-3973(02)00139-9)
- Deci, E., & Ryan, R. (2000). The what and why of goals pursuits: human needs and the self-determination of behavior. *Psychological Inquiry*, 11, 227–268. <http://dx.doi.org/10.1207/S15327965PLI1104.01>
- Eccles, J. S., Wigfield, A., Harold, R. D., & Blumenfeld, P. (1993). Age and gender differences in children's self- and task perceptions during elementary school. *Child Development*, 64, 830–847. <http://dx.doi.org/10.1111/j.1467-8624.1993.tb02946.x>
- Enders, C. K. (2001). The performance of the full information maximum likelihood estimator in multiple regression models with missing data. *Educational and Psychological Measurement*, 61, 713–740. <http://dx.doi.org/10.1177/0013164401615001>
- Enders, C. K. (2010). *Applied missing data analysis*. New York, NY: Guilford Press.
- Entwisle, D. R., & Alexander, K. L. (1998). Facilitating the transition to first grade: the nature of transition and research on factors affecting it. *Elementary School Journal*, 98, 351–364.
- Guo, G., & Harris, K. M. (2000). The mechanisms mediating the effects of poverty on children's intellectual development. *Demography*, 37, 431–447. <http://dx.doi.org/10.1353/dem.2000.0005>
- Hamre, B. K. (2014). Teachers' daily interactions with children: an essential ingredient in effective early childhood programs. *Child Development Perspectives*, 8, 223–230. <http://dx.doi.org/10.1111/cdep.12090>
- Hännikäinen, M., & Rasku-Puttonen, H. (2010). Promoting children's participation: the role of teachers in preschool and primary school learning sessions. *Early Years: An International Journal of Research and Development*, 30, 147–160. <http://dx.doi.org/10.1080/09575146.2010.485555>
- Heck, R. H., & Thomas, S. L. (2009). *An introduction to multilevel modeling techniques*. New York, NY: Routledge.
- Herbert, J., & Stipek, D. (2005). The emergence of gender differences in children's perceptions of their academic competence. *Applied Developmental Psychology*, 26, 276–295. <http://dx.doi.org/10.1016/j.appdev.2005.02.007>
- Huffman, L. R., & Speer, P. W. (2000). Academic performance among at-risk children: the role of developmentally appropriate practices. *Early Childhood Research Quarterly*, 15, 167–184. [http://dx.doi.org/10.1016/s0885-2006\(00\)00048-x](http://dx.doi.org/10.1016/s0885-2006(00)00048-x)
- Jimerson, S., Egeland, B., & Teo, A. (1999). A longitudinal study of achievement trajectories: factors associated with change. *Journal of Educational Psychology*, 91, 116–126. <http://dx.doi.org/10.1037/0022-0663.91.1.116>
- Johnson, D. R., & Young, R. (2011). Toward best practices in analyzing datasets with missing data. Comparisons and recommendations. *Journal of Marriage and Family*, 73, 926–945. <http://dx.doi.org/10.1111/j.1741-3737.2011.00861.x>
- Kikas, E., Peets, K., & Hodges, E. (2014). Collective student characteristics alter the effects of teaching practices on academic outcomes. *Journal of Applied Developmental Psychology*, 35, 273–283. <http://dx.doi.org/10.1016/j.appdev.2014.04.004>
- Leppänen, U., Niemi, P., Aunola, K., & Nurmi, J.-E. (2004). Development of reading skills among preschool and primary school pupils. *Reading Research Quarterly*, 39, 72–93. <http://dx.doi.org/10.1598/rrq.39.1.5>
- Lerkkanen, M.-K., Kikas, E., Pakarinen, E., Trossmann, K., Poikkeus, A.-M., Rasku-Puttonen, H., & Nurmi, J.-E. (2012). A validation of the early childhood classroom observation measure in Finnish and Estonian kindergartens. *Early Education and Development*, 23, 323–350. <http://dx.doi.org/10.1080/10409289.2010.527222>
- Lerkkanen, M.-K., Kiuru, N., Pakarinen, E., Viljaranta, J., Poikkeus, A.-M., Rasku-Puttonen, H., & Nurmi, J.-E. (2012). The role of teaching practices in the development of children's interest in reading and mathematics in kindergarten. *Contemporary Educational Psychology*, 37, 266–279. <http://dx.doi.org/10.1016/j.cedpsych.2011.03.004>
- Lerkkanen, M.-K., Niemi, P., Poikkeus, A.-M., Poskiparta, E., Siekkinen, M., & Nurmi, J.-E. (2006). *The first step study (Alkuportaati, ongoing)*. Finland: University of Jyväskylä.
- Lerkkanen, M.-K., Rasku-Puttonen, H., Aunola, K., & Nurmi, J.-E. (2004). Predicting reading performance during the first and the second year of primary school. *British Educational Research Journal*, 30, 67–92. <http://dx.doi.org/10.1080/01411920310001629974>
- Lewis, A. C. (2000). Playing with equity and early education. *Phi Delta Kappan*, 1, 563–564.
- Lindeman, J. (1998). *ALLU—Ala-asteen lukutesti [ALLU—reading test for primary school]*. Finland: University of Turku, Turku: The Center for Learning Research.
- Little, R. J. A. (1988). A test of missing completely at random for multivariate data with missing values. *Journal of the American Statistical Association*, 83, 1198–1202. <http://dx.doi.org/10.1080/01621459.1988.10478722>
- Logan, S., & Johnson, R. (2009). Gender differences in reading ability and attitudes: examining where those differences lie. *Journal of Research in Reading*, 32, 199–214. <http://dx.doi.org/10.1111/j.1467-9817.2008.01389.x>
- Lovett, M., Barron, R., & Benson, N. (2003). Effective remediation of word identification and decoding difficulties in school-age children with reading disabilities. In H. Swanson, H. E. Lee, & K. Harris (Eds.), *Handbook of learning disabilities* (3rd ed., pp. 273–292). New York, NY: Guilford Press.
- Marcon, R. A. (1999). Differential impact of preschool models on development and early learning of inner-city children: a three-cohort study. *Developmental Psychology*, 35, 358–375. <http://dx.doi.org/10.1037/0012-1649.35.2.358>
- McClelland, M., & Morrison, F. (2003). The emergence of learning-related social skills in preschool children. *Early Childhood Research Review Quarterly*, 18, 206–224. [http://dx.doi.org/10.1016/s0885-2006\(03\)00026-7](http://dx.doi.org/10.1016/s0885-2006(03)00026-7)
- McGraw, K. O., & Wong, S. P. (1996). Forming inferences about some intraclass correlation coefficients. *Psychological Methods*, 1, 30–46. <http://dx.doi.org/10.1037/1082-989x.1.1.30>
- Melhuish, E. (2010). Why children, parents and home learning are important. In K. Sylva, E. Melhuish, P. Sammons, I. Siraj-Blatchford, & B. Taggart (Eds.), *Early childhood matters. Evidence from the effective pre-school and primary education project* (pp. 44–69). London, England: Routledge.
- Morgan, P. L., & Fuchs, D. (2007). Is there a bidirectional relationship between children's reading skills and reading motivation? *Exceptional Children*, 73, 165–183. <http://dx.doi.org/10.1177/001440290707300203>
- Muthén, L., & Muthén, B. O. (1998–2015). Mplus users guide and Mplus version 7, retrieved from <http://www.statmodel.com/index2.html>.
- NAEYC (National Association for the Education of Young Children) (2009). Developmentally appropriate practice in early childhood programs serving children from birth through age 8. A position statement of the National Association for the Education of Young Children, available online at: www.naeyc.org/DAP (accessed 19.12.13).
- Niemi, P., Nurmi, J.-E., Lyyra, A.-L., Lerkkanen, M.-K., Lepola, J., Poskiparta, E., & Poikkeus, A.-M. (2011). Task avoidance, number skills and parental learning difficulties as predictors of poor response to instruction. *Journal of Learning Disabilities*, 44, 459–471. <http://dx.doi.org/10.1177/0022219411410290>
- Nurmi, J.-E. (2012). Students' characteristics and teacher-child relationships in instruction: a meta-analysis. *Educational Research Review*, 7, 177–197. <http://dx.doi.org/10.1016/j.edurev.2012.03.001>
- OECD. (2011). *Education at a glance 2011: OECD indicators*. Paris, France: Author.
- OECD. (2012). *PISA 2012 results in focus what 15-year-olds know and what they can do with what they know*. Paris, France: Author.
- Olinsky, A., Chen, S., & Harlow, L. (2003). The comparative efficacy of imputation methods for missing data in structural equation modeling. *European Journal of Operational Research*, 151, 53–79. [http://dx.doi.org/10.1016/s0377-2217\(02\)00578-7](http://dx.doi.org/10.1016/s0377-2217(02)00578-7)
- Pakarinen, E., Lerkkanen, M.-K., Poikkeus, A.-M., Siekkinen, M., & Nurmi, J.-E. (2011). Kindergarten teachers adjust their teaching practices in accordance with children's academic pre-skills. *Educational Psychology*, 31, 37–53. <http://dx.doi.org/10.1080/01443410.2010.517906>
- Paris, C., & Lung, P. (2008). Agency and child-centered practices in novice teachers: Autonomy, efficacy, intentionality, and reflectivity. *Journal of Early Childhood Teacher Education*, 29, 253–268. <http://dx.doi.org/10.1080/10901020802275302>
- Parrila, R., Aunola, K., Kirby, J. R., Leskinen, E., & Nurmi, J.-E. (2005). Development of individual differences in reading: results from longitudinal studies in English and Finnish. *Journal of Educational Psychology*, 97, 299–319. <http://dx.doi.org/10.1037/0022-0663.97.3.299>
- Perry, K. E., Donohue, K. M., & Weinstein, R. S. (2007). Teaching practices and the promotion of achievement and adjustment in first grade. *Journal of School Psychology*, 45, 269–292. <http://dx.doi.org/10.1016/j.jsp.2007.02.005>
- Phillips, L. M., Norris, S. P., Osmond, W. C., & Maynard, A. M. (2002). Relative reading achievement: a longitudinal study of 187 children from first through sixth grades. *Journal of Educational Psychology*, 94, 3–13. <http://dx.doi.org/10.1037/0022-0663.94.1.3>
- Raudenbush, S. W., & Bryk, A. S. (2002). *Hierarchical linear models: applications and data analysis methods*. In *Advanced quantitative techniques in the social sciences* (2nd ed.). Thousand Oaks, California: Sage.
- Robinson, J. P., & Lubienski, S. T. (2011). The development of gender achievement gaps in mathematics and reading during elementary and middle school: examining direct cognitive assessments and teacher ratings. *American Educational Research Journal*, 48, 268–302. <http://dx.doi.org/10.3102/0002831210372249>
- Salminen, J., Lerkkanen, M.-K., Poikkeus, A.-M., Pakarinen, E., Siekkinen, M., Hännikäinen, M., & Rasku-Puttonen, H. (2012). Observed classroom quality profiles in kindergarten classrooms in Finland. *Early Education and Development*, 23, 654–677. <http://dx.doi.org/10.1080/10409289.2011.574267>
- Schweinhart, L. J., & Weikart, D. P. (1988). Education for young children living in poverty: child-initiated learning or teacher-directed instruction? *The Elementary School Journal*, 89, 213–225.
- Schoorman, F., Mayer, R., & Davis, J. (2007). An integrative model of organizational trust: past, present, and future. *The Academy of Management Review*, 32, 344–354. <http://dx.doi.org/10.5465/AMR.1;2007.24348410>

- Schafer, J. L., & Graham, J. W. (2002). Missing data: our view of the state of the art. *Psychological Methods*, 7, 147–177. <http://dx.doi.org/10.1037/1082-989X.7.2.147>
- Soodla, P., Lerkkanen, M.-K., Kikas, E., Niemi, P., & Nurmi, J.-E. (2015). Does early reading instruction promote the rate of acquisition? A comparison of two transparent orthographies. *Learning and Instruction*, 38, 14–23. <http://dx.doi.org/10.1016/j.learninstruc.2015.02.002>
- Statistics Finland (2007). Statistical database. Retrieved from http://www.stat.fi/tup/tilastotietokannat/index_en.html.
- Stipek, D. J. (2004). Teaching practices in kindergarten and first grade: different strokes for different folks. *Early Childhood Research Quarterly*, 19, 548–568. <http://dx.doi.org/10.1016/j.ecresq.2004.10.010>
- Stipek, D. J., & Byler, P. (2004). The early childhood classroom observation measure. *Early Childhood Research Quarterly*, 19, 375–397. <http://dx.doi.org/10.1016/j.ecresq.2004.07.007>
- Stipek, D. J., Feiler, R., Byler, P., Ryan, R., Milburn, S., & Miller Salmon, J. (1998). Good beginnings: what difference does the program make in preparing young children for school? *Journal of Applied Developmental Psychology*, 19, 41–66. [http://dx.doi.org/10.1016/S0193-3973\(99\)80027-6](http://dx.doi.org/10.1016/S0193-3973(99)80027-6)
- Stipek, D. J., Feiler, R., Daniels, D., & Milburn, S. (1995). Effects of different instructional approaches on young children's achievement and motivation. *Child Development*, 66, 209–223. <http://dx.doi.org/10.1111/j.1467-8624.1995.tb00866.x>
- Sylva, K. (2010). Re-thinking the evidence-base for early years policy and practice. In K. Sylva, E. Melhuish, P. Sammons, I. Siraj-Blatchford, & B. Taggart (Eds.), *Early childhood matters. Evidence from the effective pre-school and primary education project* (pp. 223–235). London, England: Routledge.
- Woolfolk Hoy, A., & Weinstein, C. (2011). Student and teacher perspectives on classroom management. In C. Evertson, & C. Weinstein (Eds.), *Handbook of classroom management. Research, practice, and contemporary issues* (pp. 181–219). New York, NY: Routledge.
- Zhang, X., Koponen, T., Räsänen, P., Aunola, K., Lerkkanen, M.-K., & Nurmi, J.-E. (2014). Linguistic and spatial skills predict early arithmetic development via counting sequence knowledge. *Child Development*, 85, 1091–1107. <http://dx.doi.org/10.1111/cdev.12173>