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The development of early numeracy skills in kindergarten in low-, average- and high-performance groups

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Abstract

In this study, we investigated how early numeracy skills develop in kindergarten-age children. The participants were 235 Finnish children (111 girls and 124 boys). At the time of the first measurement, the average age of the children was 6 years. The measurements were conducted three times during 1 year of kindergarten. We used a between-group repeated-measures analysis of variance and post hoc group comparisons for three measurement times on two related mathematical scales. The results showed that differences in mathematics skills among children are already visible in kindergarten before formal primary education in mathematics starts. The early numeracy skills measured, namely, relational skills in a numerical context and counting skills, were weaker over the kindergarten year in low-performing children, and, although their skills improved, they did not catch up to their average peers.

Keywords

children, early numeracy, kindergarten, longitudinal, performance groups

*Psychologist Pekka Heiskari passed away in December 2010 due to sudden illness.

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Introduction

In this article, we report on a longitudinal study of children's mathematical skills in Finnish kindergarten. Several longitudinal studies have recently been published on mathematical development in the transition phase from kindergarten (non-formal teaching) to primary school (formal teaching) for normally developing children. These studies have targeted cognitive antecedents (Aubrey and Godfrey, 2003; Aunola et al., 2004; DeSmedt et al., 2009; Passolunghi et al., 2008), family socioeconomic status and gender (Aunola et al., 2004), motivational factors related to learning mathematics and teachers' goals (Aunola et al., 2006) and parental beliefs and parenting style (Natale et al., 2009) as predictors of mathematical performance and development. In some studies, the development of early math skills in different performance groups of children has been a focus (Aubrey et al., 2006; Aubrey and Godfrey, 2003; Desoete and Grégoire, 2006). In this study, we focused on early numeracy and how it develops in different performance groups in Finnish kindergartens. The study expands on the current literature and provides information about the development of two different, albeit related, sets of early numeracy skills during a single year of kindergarten when no formal mathematics instruction was provided to children.

Early numeracy

Bryant and Nunes (2002) have suggested that the basis for children's early mathematical development is logical thinking, the teaching of conventional counting systems and a meaningful context for learning mathematics. Early numeracy, including the ability to operate with number word sequences and enumerate combined with mathematical–logical thinking skills, is at the core of mathematics development in early childhood (Krajewski and Schneider, 2009; Sarama and Clements, 2009). According to the research on logical principles (see Piaget, 1965; Smith, 2002), the development of mathematical thinking is related to children's growing abilities to understand and make relational statements (e.g. learning what it means when a number is equal to or more than or less than another number). In other words, mathematical thinking involves the ability to compare, classify and understand one-to-one correspondence and seriation. Being able to detect one-to-one correspondence and to seriate are both essential for understanding cardinality and ordinality, which in turn are important for understanding number word sequences. The ability to compare two sets numerically is a vital aspect of conservation ability and related numerical skills, while the ability to classify is a fundamental element of mathematical reasoning in general. There is some critical research evidence from the intervention studies concerning the relevance of numerical relational skills (originating from Piaget's thinking) to later mathematics learning. For instance, Clements (1984) demonstrates that it is more useful to mathematical development to practise number skills than logical principles (i.e. numerical relational skills) with 4-year-old children. On the other hand, the longitudinal studies clearly demonstrate that numerical relational skills are an essential part of early numeracy development (Aunio and Niemivirta, 2010; Desoete et al., 2009; Stock et al., 2009).

Some authors consider the acquisition of whole number word sequence skills to be the basis for children's growing number awareness (Fuson, 1988). Based on studies done by the Dutch Realistic Mathematics Education research line, it is possible to distinguish six stages in the development of such skills: primary understanding of amounts and acoustic, asynchronic, synchronic, resultative and shortened counting (Treffers and De Moor, 1990; Van de Rijt and Van Luit, 1999). Primary understanding of amounts emerges at approximately age 2 when children show knowledge of how the different number words refer to a different number of objects, but at this stage only a very approximate discrimination of amounts is possible. When children are at the acoustic counting stage, around the age of 3 years, they can say number words, but not necessarily in the correct order, and they do not necessarily begin with one. It is as if they are reciting a nursery rhyme. When they reach the asynchronic stage, around the age of 4 years, they are able to say number words in the correct order and to point to objects, but the words and pointing are not coherent. About 6 months later, at the synchronic stage, they are able to recite number words and mark the counted objects correctly, for instance, by pointing at or moving the objects. The resultative counting stage starts around the age of 5 years, when children are able to say number words correctly, starting with one; they understand that each countable object should be marked once and that the last said number word indicates the number of objects in a set. During the shortened counting stage, at around 5½ years of age, children are able to recognize the figure 5, for instance, and can continue counting upwards from there. Although this development is described here in relation to age, it is important to understand that the ages given are rough averages from Western educational cultures, with possible wide inter-individual variation. Thus, it can be assumed that 6-year-old children (kindergarten-age children in Finland) have well-developed early numeracy, including the ability to make relational statements about numerical and non-numerical quantity situations, and to operate with number word sequences for whole numbers. In Finland, children enter the formal educational system at the age of 7 years.

Low performance in mathematics in the early primary grades

The terminology associated with mathematical learning difficulties varies considerably (see, for example, Graham and Bailey, 2007). In the literature on children's mathematical learning difficulties, the following terms are used: mathematical disability (Geary et al., 1991), at risk of mathematical disability (Geary et al., 1999), arithmetic learning disability (Jiménez González and Garcia Espínel, 1999), specific mathematics difficulty (Jordan et al., 2003), math learning disability (Mazzocco, 2001), specific arithmetic learning difficulty (McLean and Hitch, 1999), low numeracy skills (Räsänen et al., 2009), low number sense (Aunio et al., 2005) and math weakness (Bryant et al., 2000). Along with the terminology, the cut-off points in performance and other selection criteria also vary.

In identifying children who have problems in mathematical learning, two main approaches have been used (Murphy et al., 2007). The first, more traditional approach defines mathematics learning disability (MLD) according to the discrepancy between IQ and the performance level regarding standardized measures of mathematics achievement (American Psychiatric Association, 2000). In our view, children in this category have severe problems in learning basic mathematics (i.e. arithmetic) and are often identified by a psychologist as having dyscalculia or a MLD. Identification of these children is usually made in the grades above grade 3.

The second approach uses performance cut-off points in mathematics tests. As this approach does not rely on IQ testing, thereby distinguishing it from clinical practice, it can also be used by educators. However, this approach to learning difficulties presents three challenges (Murphy et al., 2007). The first is to establish what performance cut-off point most accurately captures the severity of MLDs. The second is what instrument to use to assess mathematical skills, as the selected instrument might influence whether a child is categorized as having MLDs (Desoete and Grégoire, 2006). The third challenge concerns continuous problems in identifying MLDs; should such problems occur, then follow-up measurements are required. The Responsiveness to Intervention (RTI) approach (Bryant, 2005; Deshler et al., 2005) further develops the process of identifying and supporting children with learning difficulties without the IQ discrepancy requirement.

Based on the literature, we attempted to discriminate among these terms. It is likely that children referred to as having mathematical disability or dyscalculia are mostly recognized as having neurological dysfunctions underlying their severe problems with basic mathematics. Mathematical difficulties and low performance seem to be associated with heterogeneous reasons for MLDs; in addition, children's skill profiles can be very different. In this study, we use the term 'low performance' for two reasons. The first is that we are measuring early mathematical skills, and thus can hardly talk about persistent and severe problems in basic arithmetic learning. Second, as we use only one measurement tool designed to screen out at-risk children for later mathematical learning, it is more appropriate to use the term 'low performance'.

Early mathematics learning in the Finnish context

The structured teaching of mathematical skills to young children in Finnish early childhood education (i.e. children aged 1 to 6 years) is not a common or desired practice, as in Finnish society, good preschool education is centred on children's own activities and play and does not emphasize academic learning objectives (Ministry of Social Affairs and Health, 2002; Ojala and Talts, 2007). Both Finnish parents and early childhood educators put less emphasis on pre-academic skills (see also Hujala-Huttunen, 1996). For kindergarten (i.e. instruction for 6-year-olds), the current mathematics core curriculum provided by the Finnish National Board of Education (2000) specifies the aims on a very general level. The aim is for children to have meaningful mathematical experiences of math concepts, such as classification, seriation, comparison and quantities, mainly by means of play, games, stories, songs, physical exercise and discussions, along with representational material. Teachers are not obliged to use any instruction materials; however, several publishing houses provide instruction materials for kindergarten. Most often in teaching material (e.g. Takala and Tienhaara, 2009), the instruction concentrates on mathematical relational concepts such as comparison (e.g. as many as, more, less, the same number), classification, number word sequence and enumeration skills with numbers from 0 to 5 during the first term of the kindergarten year. During the second term, the children practise mathematical relational skills (i.e. comparison, classification), number word sequence and enumeration skills with numbers from 6 to 10. Kindergarten education can be provided by social or educational authorities. The participation in kindergarten education in Finland is voluntary, but almost full enrolment is recorded nationwide (Finnish National Board of Education, 2010).

The present study

Recent research provides information about how well mathematical skills demonstrated at the kindergarten level predict later mathematics performance at school (Aubrey et al., 2006; Bodovski and Youn, 2011; Jordan et al., 2007). These studies indicate that if a child comes to school with weak early math skills, then that child will also struggle with mathematical learning later on. In this study, we investigated the development of early numeracy skills in kindergarten, that is, before the beginning of formal education. As we focused on kindergarten-age children, it was not rational to apply IQ discrepancy criteria, so we used a cut-off point approach. We used the terms low-, average- and high-performance groups, as the intention was to describe the development and the differences in the groups. We applied a longitudinal approach. The main research question was: How do early numeracy skills (relational and counting skills) develop over a period of 1 year in kindergarten among low-, average- and high-performing children?

Method

Participants

The participants in the study were 235 Finnish children (111 girls and 124 boys). At the time of the first measurement, the children were 6 years old on average (in months, M = 74.55; SD = 3.50).

The children in this study attended 18 ordinary Finnish kindergartens in the capital region. However, children with a multi-lingual background (i.e. immigrant children) or those with special educational needs were excluded from the sample. This study is the third in a series based on the norm data of 1029 children collected for the Finnish Early Numeracy Test (ENT) (Aunio et al., 2006). In addition to this norm data, we measured the skills of 83 multi-language and 174 special educational needs children (e.g. children with specific language impairment) once, but they were not followed up in a longitudinal setting (Aunio et al., 2009). The current data were collected at three measurement times (September, January and April 2003) during 1 kindergarten year.

Mathematics scale

We measured the children's early numeracy skills using the ENT (Van Luit et al., 2006). The test takes a developmental perspective on children's early numeracy and aims at tapping eight aspects of numerical knowledge, including the concepts of comparison, classification, one-to-one correspondence, seriation, the use of number words, structured counting, resultative counting and the general understanding of numbers (see Appendix 1 for examples of the items). In Finnish, there is only one test form to be used; no parallel forms exist. The target group was 4- to 7-year-old children. The test was given individually and took 25–30 minutes for a child to complete. The 40 test items were scored by giving one point for a correct answer and zero for a wrong answer; thus, the maximum score was 40. The test situation was not timed. All the children completed the measurements. We used the ENT, one form, three times during the kindergarten year, with 3- to 4-month intervals to detect development of these skills.

Although the ENT is assumed to yield a one-dimensional measure of Dutch children's early numeracy, previous studies (e.g. Aunio, Niemivirta, et al., 2006) have shown that the ENT also provides two closely related subscales that measure slightly different aspects of children's early numeracy. The first four sections of the instrument focus on the logical principles often identified as the key factors underlying children's understanding of quantities and relations (i.e. relational skills) (Piaget, 1965). The other four sections of the test focus more explicitly on the use and understanding of number knowledge and counting skills (i.e. counting skills) (Fuson, 1988).

Procedure

Volunteer educators were invited to measure the skills of the children within each group three times during the kindergarten year. The volunteers were offered a free package containing the ENT test material as compensation. Thirty-five educators from the Helsinki metropolitan area volunteered to participate in the follow-up data collection. They were trained to use the test by the first author before proceeding with the measurements. The test was administered to the children individually in their own schools, usually in a separate, quiet room with chairs and a table suitable for children. After spending a few minutes establishing a rapport with the child, the test administrator presented the question and provided the test materials (pictures, cubes, paper and pencil) called for in the instructions. The children were not given feedback as to whether their response was correct or incorrect, thus diminishing the risk of children learning from the test situation. The test administrators were also instructed not to give any extra guidance during the testing procedure. All the children were in kindergarten, so the test materials were familiar to them, as they are often used when, for instance, letters are practised.

The children were divided into three groups based on their level of performance for the first measurement time. The low-performing children were those who had −1 standard score below the total score mean (n = 39; 14 girls and 25 boys), average-performing children had scores between minus −1 standard score and +1 standard score (n = 140; 70 girls and 70 boys) and the high-performing children had mean scores +1 standard score above the total score mean (n = 56; 27 girls and 29 boys) for the first measurement time. In other words, the grouping of the children was done based on the current data, not on norms published in test manuals, as the purpose was to study the development in different groups and not to make decisions about special educational support. We found some statistically significant differences in the ages of children in the three groups. The children in the low-performance group (in months, M = 73.97) and in the average group (in months, M = 74.31) were slightly younger than the children in the high-performance group (in months, M = 75.55), $F(1, 233) = 3.22$, $p = 0.042$.

We observed no significant difference in performance between girls and boys, either within the groups or across the sample. This slightly contradicts our previous study with a larger cross-sectional sample, which showed that girls had better early numeracy, especially in relational skills (Aunio, Hautamäki et al., 2006). However, it might explain why there are fewer girls than boys in the low-performing group in the current longitudinal sample. Overall, there seems to be no consistent evidence of gender differences in this age group across the samples measured in terms of different mathematical skills (Aubrey and Godfrey, 2003; Aunola et al., 2004; Boardman, 2006; Carr and Jessup, 1997; Demie, 2001; Fennema et al., 1998; Gorard et al., 2001; Jordan et al., 2006; Strand, 1997, 1999).

There were no significant differences among the three groups in terms of the level of mothers' or fathers' educational background. Analyses of variance (ANOVAs) were used for the separate scales, the relational and the counting scales, as the scales correlated with each other (relational $scale_1$ with counting $scale_1$ $r^2 = 0.33$; relational $scale_2$ with counting $scale_2$ $r^2 = 0.27$; relational $scale_3$ with counting $scale_3$ $r^2 = 0.36$, which violates the multivariate analysis of variance (MANOVA) assumptions (Tabachnick and Fidell, 1996).

Results

Preliminary analysis

In the preliminary analysis, we calculated the reliability coefficients for each measurement time and found they were satisfactory for both the relational and counting scales; however, the coefficients were lower for the relational scale compared to the counting scale. The Cronbach's alpha for the relational scale in the first measurement time was 0.67 (M = 16.63, SD = 2.56), 0.66 (M = 17.87, SD = 2.11) in the second measurement time and 0.58 (M = 18.44, SD = 1.65) in the third measurement time (Figure 1). The Cronbach's alpha for the counting scale in the first measurement time was 0.82 (M = 11.48, SD = 4.42), 0.81 (M = 14.18, SD = 3.99) in the second measurement time and 0.79 (M = 15.55, SD = 3.54) in the third measurement time (Figure 2).

Main analysis

We found significant differences in the between-groups repeated-measures ANOVA for the three measurement times in terms of the relational scale, $F(2, 232) = 115.31$, $p < 0.0001$, $\eta^2 = 0.50$. The group differences were also significant for the counting scale, $F(2, 232) = 191.14$, $p < 0.0001$, $\eta^2 = 0.62$. There were no significant interaction effects on the mean scores in the different measurement times in the group comparisons, as the low-performing children scored lowest and the average-performing children scored the second lowest in all measurement times on both scales. The post hoc comparison analysis revealed that the differences were statistically significant ($p < 0.05$) between the different groups for all measurement times. Descriptive indicators of the scales are reported in Table 1.

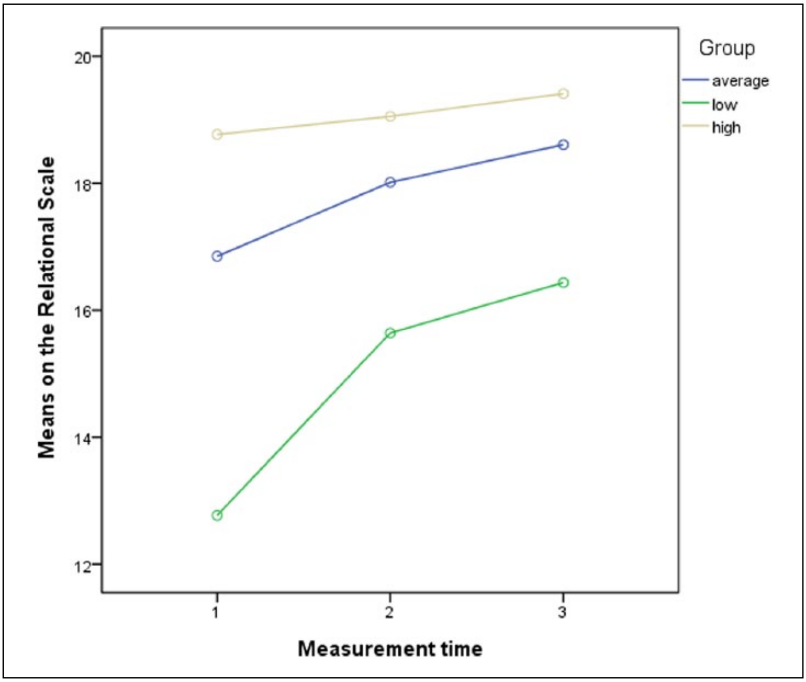

Figure 1. Children's relational skills at three measurement times.

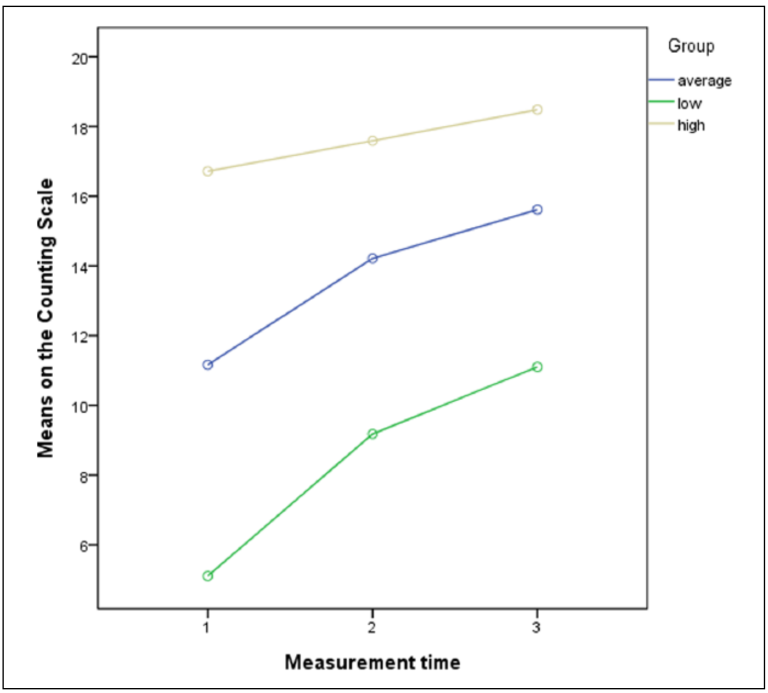

Figure 2. Children's counting skills at three measurement times.

Table 1. Descriptive statistics for scales and gains in raw scores of performance groups.

Scale	Low performing (n = 39)						Average performing (n = 140)						High performing (n = 56)					
	Measurement time						Measurement time						Measurement time					
	1		2		3		1		2		3		1		2		3	
	M	(SD)	M	(SD)	M	(SD)	M	(SD)	M	(SD)	M	(SD)	M	(SD)	M	(SD)	M	(SD)
Relational	12.77	(2.38)	15.64	(2.83)	16.44	(2.02)	16.85	(1.79)	18.01	(1.64)	18.61	(1.29)	18.77	(0.81)	19.05	(1.26)	19.41	(0.85)
Gain 1			2.87	(1.98)					1.16	(2.08)					0.29	(1.40)		
Gain 2					.79	(2.12)					0.59	(1.46)					0.36	(0.94)
Gain 3					3.67	(1.54)					1.76	(1.87)					0.64	(1.02)
Counting	5.10	(2.09)	9.18	(3.52)	11.10	(3.87)	11.16	(2.90)	14.21	(3.25)	15.61	(2.69)	16.71	(1.35)	17.59	(1.74)	18.48	(1.29)
Gain 1			4.08	(3.09)					3.05	(3.10)					0.88	(1.75)		
Gain 2					1.92	(2.99)					1.40	(2.77)					0.89	(1.32)
Gain 3					6.00	(3.37)					4.45	(2.97)					1.77	(1.51)

The maximum score for both scales is 20. Gain 1 is the raw score increase between the second and first measurements. Gain 2 is the raw score increase between the third and second measurements; Gain 3 is the raw score increase between the third and first measurements.

In addition to the differences in the performance levels for the three measurement times, we also analyzed the differences in gain scores. Regarding the between-group repeated-measures ANOVA for measurement times from Time 1 to Time 2 and from Time 2 to Time 3, the differences in gain scores were significant for the relational scale, $F(2, 232) = 38.67$, $p < 0.0001$, $\eta^2 = 0.25$. The results were similar for the counting scale $F(2, 232) = 30.01$, $p < 0.0001$, $\eta^2 = 0.21$. The post hoc comparisons of the groups regarding gains on the relational scale revealed that the groups differed (a statistical significance of $p < 0.05$) from each other from Time 1 to Time 2 and from Time 1 to Time 3. The post hoc comparisons among the groups regarding gains on the counting scale revealed statistically significant ($p < 0.05$) group differences from Time 1 to Time 2 between low and high and in the average and high groups, but not between the low- and average-performance groups. Regarding the gains between Time 1 and Time 3, significant differences can be found between all groups ($p <.05$). There was no group difference from Time 2 to Time 3 on any scale. The gains on both scales were greatest for the low-performance group, followed by the average-performance and then the high-performance groups. One reason for no gain differences between the second and third measurement times might be that there were ceiling effects of scores, especially regarding the relational scale in Time 2 and Time 3, in the average- and high-performance groups. However, the test was able to detect the performance growth in the low-performance group. There were two noteworthy facts. First, although there were possible ceiling effects on the average- and high-achieving groups' performance, the low-performing group did not catch up. Second, at the end of kindergarten, the low-achieving group did reach the level of the children in the average-achieving group when they started kindergarten.

Discussion

In this study, we investigated how early numeracy skills developed in kindergarten-age children, that is, before the beginning of compulsory primary school, in Finland. The results showed that differences in mathematics between the children can already be found in kindergarten before formal primary education in mathematics begins. Moreover, differences were found in two sets of early numeracy skills, namely, relational understanding and counting skills. The group differences were also sustained over the kindergarten year; at least, the low-performing group remained weak throughout the whole year. The children in the low-performance group scored lower on both scales than their peers. A noteworthy result is that the early numeracy development was faster in the low-performance group than in the average- and high-performance groups, although the low-performing children did not catch up to the average group during the kindergarten year.

The results are comparable to those of other studies measuring the development of mathematical skills in the early primary school years (Aubrey et al., 2006; Aunola et al., 2004; Jordan et al., 2007). However, these results give a more detailed picture. We used two distinct, albeit related, sets of preparatory mathematical skills in our analysis and were able to demonstrate that the low-performing children had problems with both sets of skills. This means that the instruction given in kindergarten was not able to support the children's mathematical skills in such a way that the low performers could catch up to the other children, as they reached the level the average-performing children had at the beginning of the kindergarten year by the end of kindergarten. This observation needs to be understood in the Finnish context, in which kindergarten education has mainly focused on social and literacy development (National Board of Education, 2000; Scarborough, 1998) and less emphasis has been put on supporting children's mathematical development. Perhaps the educators have not realized the relevance of early numeracy skills to later mathematical learning. The reasons for low performance were not explained by family background, as is often reported in the United States (Jordan et al., 2009), as we found no differences relating to the parental education level. Sylva et al. (2004) concluded that the quality of preschool education and the home learning environment were significant contributors to children's intellectual and social development. It is plausible to suggest that in our study, the learning experience at home and in early childhood education before the kindergarten year can explain the performance differences between the children. It is also possible that the children in the low-performing group were also generally low-achieving children. If so, quality educational and special educational support would be greatly needed from early on so that children would be able to practise their learning skills. Whatever the reason, the average kindergarten learning environment in Finland was not sufficient to close the achievement gap in early numeracy between these groups of children. The future challenge of early childhood education and primary education is to respond to this discrepancy in children's skills, here demonstrated in early math skills. The key aspect here seems to be good-quality scientifically based education for educators, either as basic training in teacher education institutions or professional development training for teachers already working in early childhood education or primary schools (Darling-Hammond and Bransford, 2005).

The results indicate it was hard for the low-performing children to enumerate and thus solve problems requiring counting; this has direct pedagogical implications. Longitudinal research with kindergarten and primary grade children has demonstrated that counting skills (i.e. reciting number word sequences and enumeration), especially at kindergarten age, are powerful predictors of successful learning of basic arithmetic skills in the primary grades (Jordan et al., 2007). Low-performing children need opportunities to learn and practise their counting skills so they will be prepared to learn mathematics in the primary grades. Moreover, it should be kept in mind that counting skills are developmentally related to the other early numeracy skills (Aunio et al., 2006; Krajewski and Schneider, 2009) and it should be regarded in early childhood mathematics education practice (Sarama and Clements, 2009). Some pedagogical ways to support the low-performing children might be small group interventions (e.g. Van Luit et al., 2010; Wright et al., 2006) or computer-assisted practice (e.g. Number Race, n.d.).

There are some limitations in our study. One concerns the limitations of the selected test, the ENT, to detect the performance growth in average- and high-achieving groups. Due to possible ceiling effects of the scores at the end of kindergarten for the high-achieving group, we were unable to describe this group's mathematical knowledge in a valid way. However, the test was able to determine the performance of the lowest performance group. Another limitation is that our results rely only on one early numeracy test; other factors, such as language skills or working memory capacity, would have given a more holistic picture of the children's learning and development. In addition, using different mathematical tasks, such as number line tasks (Siegler and Ramani, 2009) or verbally given problem-solving tasks, would have given more valuable information about the children's skills.

Our study has implications for early education. In line with evidence from England (Sylva et al., 2004) and New Zealand (Anthony and Walshaw, 2009), we suggest increasing the level of early childhood education staff members' knowledge of mathematical development in children and skills to provide children with effective and motivating mathematical learning environments. In the long term, we also need to develop kindergarten and preschool teachers' competencies in identifying low-performing children who are at risk of later MLDs. We also need to provide these educators with the knowledge and skills relating to preparatory mathematical interventions to better equip them for the assessment-intervention process.

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Appendix 1

A description of the Early Numeracy Test item groups according to Van de Rijt et al. (1999) and Van Luit et al. (1994).

(1) Comparison. This aspect is about the use of concepts in making comparisons between two non-equivalent cardinal, ordinal and measurement situations. The child has to demonstrate an understanding of concepts in drawings of order relations. *A sample item (4): Here are some Indians. Can you point out the Indian who has fewer feathers than the one you see here?*

(2) Classification. These tasks require the grouping of objects in a class on the basis of one or more features. *A sample item (6): Look at these squares. Can you point out the square with five blocks but no triangles?*
(3) Drawing correspondences. This includes tasks that measure children's understanding of one-to-one relationships between simultaneously presented objects. Overt and covert indicating tasks (e.g. moving blocks, drawing lines, pointing) are necessary in responding to the one-to-one correspondence items. *A sample item (12): (The child has 15 blocks.) The test administrator shows a drawing representing two dice showing 5 and 6. Then the administrator asks: Can you put as many blocks on the table as are shown on the dice here?*
(4) Seriation. This aspect refers to dealing with discrete and ordered entities. *A sample item (19): (The child has a paper and pencil.) Here are some dogs. Each dog is going to fetch a stick. The big dog is going to fetch a big stick, and the small dog is going to fetch a small stick. Can you draw lines from all of the dogs to the sticks that they fetch?*
(5) Using number words. These tasks involve the ability to use number words in number word sequences up to 20. Number words must be produced forwards and backwards. *A sample item (23): Count from 9 upwards. I say when to stop.*
(6) Synchronous and shortened counting. This refers to the counting of objects in organized and unorganized arrangements by pointing. *A sample item (28): The test administrator puts 20 blocks on the table in an unorganized manner. The child is required to count the blocks. The child is allowed to point a finger at the blocks or to move them.*
(7) Resultative counting. This requires accurate counting and last-word responses; pointing is not allowed. Most questions are of the following kind: How many Xs are there? *A sample item (33): The test administrator puts 15 blocks on the table in three rows of five with some space in between them and asks: How many blocks are there? The child is not allowed to point a finger at the blocks or to move them.*
(8) General knowledge of numbers. This refers to the application of numeracy in daily life situations, which are represented in drawings. *A sample item (38): The test administrator points to a picture of eight chickens and says: A farmer has eight chickens. He buys two more. The test administrator then points to the picture with two chickens and continues: How many chickens does the farmer have now? Show the square with the right answer. The test administrator points to the row of squares at the bottom of the paper.*