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Relationship between Early Mathematical Competence, Gender and Social Background in Chilean Elementary School Population

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Título: Relación entre los niveles de competencia matemática temprana, género y extracción social en la población escolar primaria en Chile.
Resumen: El artículo describe los niveles de competencia matemática temprana que presentan prescolares y estudiantes de primer ciclo de educación primaria chilenos, en los dominios de competencia relacional y numérica (*N* = 1437), evaluados mediante el Test de Evaluación Matemática Temprana versión Utrech (TEMT-U). El estudio permite constatar que existen diferencias significativas en el nivel de competencia matemática temprana, en relación al nivel académico y a la edad cronológica de los niños y niñas, no así respecto del sexo de los escolares y del grupo de extracción social. Los resultados indican que la extracción social y el género no constituyen un factor explicativo asociado a la competencia matemática temprana en niveles iniciales de escolaridad, contrariamente a lo que sucede en años posteriores, indicando que quizás es la calidad de la acción educativa la que marca las diferencias
Palabras clave: competencia matemática temprana; extracción social; género; educación inicial.

Abstract: The article describes the levels of early mathematical competence shown by Chilean pre-schoolers and primary students related to relational and numerical competence (*N* = 1437) that were assessed by means of the Early Mathematical Evaluation Test in its Utrecht version (TEMT-U). The study confirms that there are significant differences concerning early mathematical competence with regard to the academic level and children's chronological age; however, neither gender nor social backgrounds are relevant in that respect. Results show that social background and gender do not represent an explanatory factor related to mathematical competence in initial schooling levels; the opposite happens in later years, which suggests that perhaps it is the quality of the educational action what makes the difference.
Key words: early mathematical competence; social background; gender; initial education.

Introduction

In Chile, students' level of achievement in mathematics presents a very low index, especially in the last years of elementary education and throughout secondary education, as evidenced by the results achieved by students in numerous national and international tests (i.e. *Sistema Nacional de Evaluación de resultados de aprendizaje del Ministerio de Educación de Chile* [SIMCE], MINEDUC, 2004; 2007a; 2010a, 2010b, Program for international Student Assessment [PISA], and Trends in International Mathematics and Science Study [TIMMS]). However, only a very small number of studies, carried out with the same level of depth and analysis, show the level of students' achievement in the first few years of elementary education. The latter is quite negative, because, as it is known, the diagnosis and verification of basic competences at an early age, allows better preventive measures and remedial actions to be taken. A diagnosis at this stage should have an eminently formative character and would be able to highlight the specific difficulties children have, and therefore provide the opportunity to consider corrective policies in this important domain of compulsory schooling, especially when there is clear evidence that mathematical skills are one of the most powerful explanatory variables in students' academic performance (Miñano, Gilar & Castejón, 2012).

Classic references in this field date back to Piaget's work on logical-mathematical development (1959), which revealed what he calls "intuitive mathematics", an ability to understand the principles of addition and subtraction using objects by adding or removing them from a container. According to Piaget, young children are able to understand situations in which elements are added from one source, but not when they are added from two sources simultaneously. From this point of view, until children reach the stage of concrete operations, it is not possible for them to have a thorough understanding of the concept of number.

According to Piaget (1965), there are logical requirements that are critical to the understanding of number: comparison, seriation, classification, and one to one correspondence. These operations are crucial since they are involved in logic relationships, correspondence, hierarchy of objects or amounts, order of elements, and concepts of class and subclass. However, from a reductionist perspective, a number of studies challenge theories that propose the psychological origin of the concept of number either because of logic of class or because of asymmetric reductions, i.e. even if classification and seriation are complementary to numerical activities (Serrano & Pons, 2008). Bryant & Nunes (2002), however, suggest that in addition to logical thinking, the basis of mathematical development is also grounded in meaningful and contextualized learning as well as in the conventional numbering system. Authors like Baroody (2000) and Bryant & Nunes (2002), among others, have pointed out that a child at an early age is able to differentiate a set with more items from another with fewer objects before being able to quantify how many items there are in each set. A three year old child knows when an object has been added or removed and is able to point out that there are more or fewer objects than before. Studies have found evidence of this phenomenon in even younger children. Wynn,

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Bloom & Chiang (2002) discovered five-month-old babies could identify and count groups of objects. Meanwhile, Brannon (2002) found evidence that understanding of ordinal relations occurs between 9 to 11 months of age. The findings of Sarnecka & Carey (2008) support the idea that young children know cardinal aspects of number, and are able to recognize whether or not two sets of objects have the same amount of objects. At present, some studies in neuroscience have recognized a specific neuronal substrate (parietal lobe) of the concept of number in very young children (Chen & Walsh, 2009). Likewise, evidence has also been found that basic arithmetic operations would operate independently, inferring that the cognitive processes involved in these operations would be different. This is relevant because there is some agreement about the fact that the cognitive mechanisms and associated cortical areas involved in numerical recoding tasks, such as reading numbers, labeling and verbal counting, would be the same as the ones involved in linguistic processing (Salguero-Alcañiz and Alameda-Bailen, 2013).

The interesting construct behind mathematical competence

The early mathematical competence construct assumes that the so-called Piagetian logical operations and counting skills contribute significantly to the development of mathematics. Authors, such as Barouillet & Camos (2002), Lehalle (2002) and Howell & Kemp (2005) argue that mathematical skills are developed through gradual exercise, starting with simple counting activities. One of the main indications of the capability to count in children is their ability to make judgments about the numbers and compare magnitudes (Jordan, Kaplan, Ramineni & Locuniak, 2009), which subsequently becomes automatic and more efficient. In this regard, a research which studied children between four and six years old found evidence that counting strategies exclusively emerge when faced to addition and subtraction, and those implying derived knowledge such as multiplication and division (Rodríguez et al., 2008). Baroody (2000) states that the capability to count comprises six stages, which are: setting an established order in a coherent sequence, matching a label to each element to be counted, identifying units, assigning a unique tag to each cardinal, abstracting, i.e. counting the objects in a homogenous or heterogeneous set, and understanding that the last label in a set represents the cardinal and being able to determine that the cardinal of a set does not change if its distribution changes. Van de Rijt & Van Luit (1998) propose the interactionist approach, which postulates that both logical operations and the capability to count contribute to the development of the early mathematical competence.

The assessment of early mathematical competences has gradually been consolidated since the acquisition of these competences is a prerequisite to pursue a formal mathematical education (Van de Rijt, Van Luit & Pennings, 1999). A study conducted by Jordan, Kaplan, Locuniak & Ramineni (2007), in which the level of math skills was examined in children from preschool level according to their age of entry into kindergarten, gender, and family income, showed that the level observed in this variable is a strong predictor of math achievement at the end of the first grade of elementary school. Jordan, Mulhern & Wylie (2009) also state that a high level of mathematical competence in pre-school students significantly predict their later mathematical achievements, even up to third year of elementary school. Among all skills, the ones associated with basic calculation could be an important predictor for mathematical development (Cowan, 2008). Results obtained in studies performed by Locuniak & Jordan (2008) and Mazzocco & Thompson (2005) support the fact that the first acquired mathematical competences predict outcomes related to general cognitive, verbal and spatial competences as well as memory skills. Longitudinal studies carried out by Byrnes & Wasik (2009), Clarke & Shinn (2004), Krajewski & Schneider (2009), Foegen & Lembke (2009) and Methe, Hintze & Floyd (2008) indicate that counting, discriminating different amounts, number recognition, as well as verbal and nonverbal calculation, are strong predictors of the achievement obtained in later stages and would be related to the level and rate of learning during the first years of schooling (Locuniak & Jordan, 2008). This is consistent with studies that have examined the way the presence of higher cognitive processes at an early age, such as phonological and spatial awareness, mechanisms of executive control, subitizing processes and numerical awareness can predict or explain the different performance in mathematics (Geary, Bailey, Littlefield, Wood, Nugent & Hoard, 2009; Kroesbergen, Van Luit, Van Lieshout, & Van De Van Loosbroek Rijt, 2009; Stock, Desoete & Roeyers, 2009).

Moreover, even if mathematical competences show a high individual variability among pre-school students (Van de Rijt & Van Luit, 1998), longitudinal studies show that these differences are maintained throughout their development, and students tend to remain in the same range in comparison to their peers throughout elementary and secondary school. These studies also show that as time goes on, these early differences increase. At present, the predictive role of early mathematical competences, both numerical and relational in later school achievement in mathematics, has been altered by variables related to executive functions such as working memory, both visual-spatial and especially verbal, as well as specific factors such as subitizing (Kroesbergen et al., 2009, Toll & Van Luit, 2013a).

All these findings suggest that reinforcing mathematical learning in early school years could bring a great benefit to students over time. Based on this, the ability to timely diagnose the levels of early mathematical competence is particularly relevant. Therefore, the present study focuses on answering the following question: are there significant differences in the level of mathematical competence in the areas of comparison, classification, correspondence, seriation, using counting words, structured counting, resultative counting and general knowledge of numbers in relation to variables of age, gender, academic level and social class?

The recent adaptation and validation in Chile of the Early Mathematical Evaluation Test in its Utrecht version, which is a Spanish version of the Utrecht Early Numeracy Test, allows a wider assessment range in this domain with preschoolers and primary students (4 to 8 years) to be assessed. The TEMT-U was created by Johannes van Luit, Bernadette van de Rijt and Alber Pennings (Van de Rijt et al., 1999). The test was later standardized in Spain (Navarro et al., 2009) and is recently available for the Chilean population (Cerda et al., 2012).

In this study, we have attempted to determine whether, at a young age, it is possible to establish differences in academic mathematical achievement, differences which, at least in our country, are observed in higher levels of education and consider gender and types of schools students attend. We assume that the school system in Chile is strongly stratified and schools have an important socio-economic homogenization in terms of family income and parent's education level (Mizala, Romaguera & Urquiola, 2007). This is the reason that municipal (low socioeconomic background) schools preferably have students from poorer socio-economic segments, as well as children with discipline problems who have been expelled from private schools. On the other hand, semi-private (middle socioeconomic background) schools have children that come from families with average income levels and tend to select their students through some mechanisms (Garcia-Huidobro, 2007). Along with this we plan to study whether there are differences in students' early mathematical competence taking into account academic level and age.

Method

The present research is a correlational descriptive study based on a quantitative approach. Its main objective is to characterize and report levels of mathematical competences as well as their distinctive characteristics, in a representative group of pre-school and primary school students, according to the attributive variables above mentioned.

Participants

Stratified sampling was performed taking into account the following variables: social background, gender and academic level. The final sample consisted of a total of 1437 participants (50.8% female and 49.2% male). The average age was 76.58 months with a standard deviation of 11.79 months.

Tables 1 and 2 show the composition of the sample used in this study, according to level of education, age and gender.

Table 1. Distribution of the final simple according to social background and academic level.

	Social Background			
Educational level	Low	Medium	Total	Percentage
First Transition Level	89	189	278	19.35%
Second Transition Level	73	261	334	23.26%
First Grade, Elementary Ed.	148	378	526	36.64%
Second Grade, Elementary Ed.	161	137	298	20.75%
Total	471	965	1436	100%

Table 2. Age of participants grouped at 6 months intervals distributed according to gender.

Age	Boys	Girls
4.1 - 4.6	23	18
4.7 – 5	82	69
5.1 - 5.6	77	75
5.7 – 6	91	67
6.1 - 6.6	119	93
6.7 – 7	129	146
7.1 - 7.6	135	159
7.7 – 8	74	80
Total	730	707

Instruments

TEMT-U has three parallel versions (version A, B and C) consisting of 40 items each. This study used the version A, which has 8 exercises or competence areas, divided in groups of 5. It has a maximum score of 40 points, one point for each correct item. The test showed a high level of reliability (r_a = .915). Similarly, the TEMT-U adaptation study in Chile, showed that correlations between the different areas of the TEMT-U test were statistically significant, which proves the uni-dimensionality of the results it yields, meaning the eight individual dimensions are linked to the same mathematical competence. The factorial analysis of the principal components shows that around 60% the variance in the scores is explained by that factor, which is consistent with results reported by the authors of the original test (Cerda et al., 2012; Van de Rijt et al., 1999).

The 18th version of the SPSS® program was used for the tabulation and the analysis of the results.

Procedure

Given the characteristics of individual application of the TEMT-U test, this was done after a period the boys and girls got familiarized with it. Once the boys and girls got to know the teachers in charge of the implementation, assessment proceeded in a quiet area of each school for about 20 to 30 minutes. All assessment sessions were performed with the conformed consent of the children's parents and of the school authorities.

Results

Levels of mathematical competence en relation to age and educational level

Considering the TEMT-U test has a 40 points perfect score, average performance of 29.75 points was observed, with a standard deviation of 7.83 points. The results of the relational subtest were higher than the ones obtained in the numerical subtest (M = 16.35, SD = 3.11 and M = 13.46, SD = 5.16 respectively).

When analyzing the results in relation to educational level, a progressive and consistent increase was observed (see Table 3). A clear tendency to higher scores is observed when the educational level of the participants increased. The same is observed when disaggregating the respective performances in the relational and numerical subtests (see Table 4).

Table 3. Mean values (M) and Standard Deviation (SD) obtained by TEMT-U participants according to educational level.

	Total Scoring	
Educational level	M	SD
First Preschool Level	19.89	7.36
Second Preschool Level	27.73	6.86
1st Grade Primary Ed.	33.08	4.55
2nd Grade Primary Ed.	35.29	3.27
Total	29.74	7.84

Table 4. Mean value (M) and Standard Deviation (SD) obtained by the participants in the TEMT-U according to age.

	Relational Subtest Score		Numerical Subtest Score	
Age	M	SD	M	SD
4.1 - 4.6	11.88	4.52	4.68	3.95
4.7 - 5	12.87	3.56	6.38	4.23
5.1 - 5.6	14.73	2.99	9.32	4.59
5.7 - 6	15.86	3.28	11.99	4.29
6.1 - 6.6	16.68	2.33	13.90	3.95
6.7 - 7	17.35	2.01	15.80	2.88
7.1 - 7.6	17.89	1.82	16.77	2.59
7.7 - 8	17.90	1.72	17.29	2.07

Moreover, in general, it appears that the subclasses with the highest mean values were the ones related to comparison (M = 4.59, SD = .73), classification (M = 4.39, SD = .85), and correspondence (M = 3.97, SD = 1.13). Meanwhile, subclasses that obtained the lowest means were resultative counting (M = 2.93, SD = 1.55), structured counting (M = 3.02, SD = 1.51) and sequencing (M = 3.38, SD = 1.41). It can be clearly observed that the means of the numerical subtest are consistently lower than those obtained in the relational subtest for the entire sample in all age ranges.

Mathematical competence levels by gender

With respect to the results by gender of the students, it is interesting to note that there were no significant differences in mean and typical deviation values between male and female students. Although the mean score obtained by boys was slightly higher (M = 29.96 points, SD = 7.95 against M = 29.54 points, SD = 7.72 respectively), it is not statistically significant at the 99% confidence. The same results are obtained if we analyze comparatively the performance of boys and girls in each subtest.

Early mathematical competence and socio-economic background

Finally, the socio-economic background variable was analyzed. This variable was linked to the type of school students attended: semi-private schools (middle socio-economic level) and public-municipal schools (low socio-economic level).

Results did not show significant differences in both the relational subtest and in the numerical subtest. There were no significant differences in the total test score either. Boys and girls from middle socio-economic background groups reached a slightly higher global average score (M = 29.80 points, SD = 7.88), which is not significant at the 99% confidence, in comparison to those obtained by boys and girls of lower socio-economic background (M = 29.64 points, SD = 7.76). Similarly, the comparative analysis of the scores of the subtests does not show significant differences. An analysis of the subclasses allows to verify that only in the component of correspondence in the relational subtest, students from middle socio-economic background show higher scores than the students from the lower socio-economic background [F (1, 1435) = 8.110, p < .004].

The comparative analysis of the means by age through variance analysis reveals significant differences at the 99% level of confidence in the whole relational subtest [F (5, 1431) = 133.57, p < .000], numerical subtest [F (5, 1431) = 332.84, p < .000] and Total Test Score [F (5, 1431) = 283.39, p < .000], in which the score of the students increases gradually according to age group in the respective tests.

As for the age variable, the mean differences are replicated for the academic level variable, because they were found to be statistically significant at the 99% confidence in the whole relational subtest [F (3, 1433) = 201.88, p < .000], numerical subtest [F (3, 1433) = 575.26, p < .000] and total test score [F (3, 1433) = 463.31, p < .000], in which the mean scores increase again as students reach later stages in academic level.

Finally, a significant step forward of the performance in the total score was observed, when moving from the First Transition Level (M = 19.89 points, SD = 7.361) to the Second Transition Level (M = 27.73 points, SD = 6.862). This situation changes from 1st to 2nd year elementary school, where the scores tend to be similar and homogeneous (M = 33.08 points, SD = 4.551) and (M = 35.29 points, SD = 3.262), respectively.

To determine the combined effect on the results in the TEMT-U test of the variables: gender, academic level, age and social background, a factorial analysis of variance was carried out, which allowed to observe that there is no significant effect in the interaction of these factors, F (3, 1436) = .221, p = .88 ($eta^2_{partial}$ = .000). For the interaction effects of third order, there were no significant interactions between gender, social background and educational level, F (3, 1436) = .31, p = .82 ($eta^2_{partial}$ = .001) and between gender, educational level and age, F (5, 1436) = .62, p = .68 ($eta^2_{partial}$ = .002) and between gender, educational level and age, F (5, 1436) = .62, p = .68 ($eta^2_{partial}$ = .002). Neither showed a significant effect for the interaction between gender, educational level and age, F (6, 1436) = 1.60, p = .14 ($eta^2_{partial}$ = .007), nor between gender, social background and age F (7, 1436) = .62, p = .74 ($eta^2_{partial}$ = .003). Regarding second-order interactions, most of them were significant except the interaction between gender and social background F (1, 1436) = 5.38, p < .02 ($eta^2_{partial}$ = .004). Figures 1 and 2 show the marginal means for combinations of age and social background by gender of students.

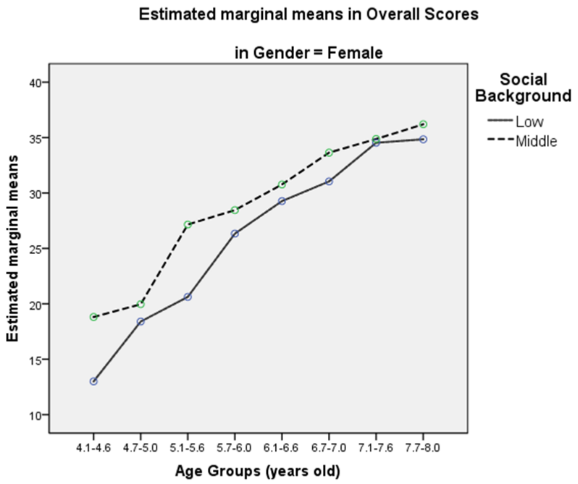

Figure 1. Marginal means in TEMT-U test of girls for the interaction of age groups (in years) and social background (Dashed line: Middle, Solid line: Low).

The analysis of the main effects established that three of the four factors had significant effects. The comparison of social background groups F (1, 1436) = 8.15, p < .004 ($eta^2_{partial}$ = .006) shows that students belonging to groups of middle social background have slightly higher scores than students in groups of low social background. As for age, significant differences are found in the mean scores of TEMT-U F (7, 1436) = 3.18, p < .000 ($eta^2_{partial}$ = .006), which is confirmed by the existence of significant differences in the mean scores of TEMT-U by educational level, F (3, 1436) = 6.14, p = .79 ($eta^2_{partial}$ = .016). Finally, there were no significant differences when comparing the outcomes of boys and girls F (1, 1436) = .71, p <.79 ($eta^2_{partial}$ = .000).

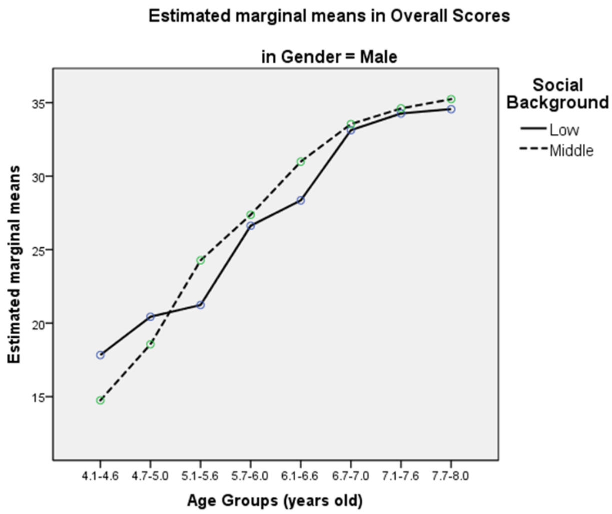

Figure 2. Marginal means in TEMT-U test of boys for the interaction of age groups (in years) and social background (Dashed line: Middle, Solid line: Low).

In order to analyze the combined effect of the variables gender, educational level, age and social background, with respect to the level of development of early math skills a linear regression analysis was carried out, which allowed, in turn, to assess the relative weights of these variables on the variability of the scores. The results corresponded to a coefficient R^2 = .501, F (4, 1431) = 359.87, p < .001. From this we can conclude that the set of predictor variables explained 50 % of the variability in scores that students obtained in the tasks of early math skills. When analyzing the effect of individual predictors, it seems that almost all of them relate significantly with the dependent variable. In particular, we observed that students with high scores on the test are characterized by older age (β = .415, p < .001), who belonged to higher educational levels (β = .316, p < .001), and to middle social background (β = .113, p < .001). There was no significant relationship with their gender (β = -.022, *p n.s.*).

Discussion

Perhaps the most important conclusion of this study is that there are no significant differences in the development of early math skills based on social background (middle and low), or gender, regardless of the educational level of the students, pre-school or first levels of primary school. This is also verified by comparing the results of the scores in the relational and numerical skills subtests. The only exception is the skill related to one-to-one correspondence tasks or to matching one to one the elements in a set, in which students from middle social background obtained higher scores than the group of students from low social background. This finding is in line with other research which found that the differences between boys and girls in the early years in mathematics performance are not significant (Klein, Adi-

Japha & Hakak-Benizri, 2010; Lachance & Mazzoco, 2006; Navarro et al., 2009; Navarro, Aguilar, Marchena, Alcalde and García, 2010; Van de Rijt, 1996). In Chile, the data provided by national assessments confirm that after the first cycle of elementary education there are no significant differences in achievement levels in mathematics between boys and girls, contrary to what happens at the end of secondary education, when boys have better performance than girls (MINEDUC, 2007b, 2007c). International research suggests that these differences could be explained by spatial reasoning skills, attitudinal issues and stereotypes associated differentially to males and females (Ganley & Vasilyeva, 2011; Good, Aronson & Harder, 2008; Yaratan & Kasapoglu, 2012).

This is an important milestone in the study, because it would indicate that the student's initial knowledge related to early math skills in the beginning of the Chilean educational system is equal for both social backgrounds (middle and low) and for both genders. Results suggest that students in their first school years have similar competences or that the impact of teaching has not yet affected their development, or maybe because both types of schools (semi-private and public-municipal) share similar teaching methods and achieve the same quality of instruction. The differences observed later in higher educational levels could be explained because children from higher social background not only have a better cognitive development, but show incremental relationships associated specifically with academic achievement (Tucker-Drob & Paige, 2013), or maybe parents give them access to better opportunities: attending a more prestigious school, or a school near their home, and a better family environment. It has been generally observed that the effect of the socio-economic background may be moderate in low social background groups, if parents provide opportunities for their children, or make intentional parenting practices to improve the learning of mathematics or to encourage self-regulation (Aubrey, Shen & Byrnes, 2013; Greenman, Bodovski & Reed, 2012).

The findings show the crucial importance of the role and responsibility of educational agents in the Chilean school system, especially in the municipal (low income) education system, due to the high social stratification of the educational system, particularly in relation to the socio-economic background of the students. This is even more evident when we compare students from high and low socio-economic backgrounds using the Duncan index, which ranged from .50 to .60 in 2008 (Valenzuela, Bellei & De los Ríos, 2013). In particular, students from low social background show lower scores on curricular or disciplinary aspects and also for generic math skills associated with their performance (Cerda, Pérez & Melipillán, 2010a, 2010b; Cerda, Ortega, Pérez, Flores & Melipillán, 2011; Okpala & Okpala, 2001; Ramirez, 2006; Woolley et al., 2008). Perhaps parents of higher social background have and express higher expectations about their children's academic activities, which results in an improvement of their the academic performance, providing more and more varied activities with numbers or simply allowing their children to interact with more resources or materials that support math learning (Byrnes & Wasik, 2009; Ee, Wong & Aunio, 2006; Jordan et al., 2009).

This study shows that the levels of early math skills of pre-school and primary school students increase progressively depending on their age and educational level. From the point view of the gradual development of students' skills, results are similar to those obtained with the same instrument in other countries such as England, Finland, Spain and China (Alcalde, Aguilar, Marchena & Ruiz, 2006; Aunio, Aubrey, Godfrey & Liu, 2008; Aunio, Hautamäki, Sajaniemi & Van Luit, 2009; Navarro et al., 2009; Navarro et al., 2010), although it differs from the results obtained in Singapore, a country where studies show a discontinuous development profile. There, scores gradually increase to reach a peak in the curve at 73 months, and then they start to descend (Ee et al., 2006). In this regard, it is known that in certain Asian regions, parents put high pressure on their children to succeed academically, especially in mathematics, providing them with varied activities and resources, purchases of didactic and educational materials to encourage practice of mathematical skills (Ee et al., 2006).

With respect to the numerical skills subtest, younger preschool students achieve significantly lower mean scores, which is consistent with the general Piagetian pattern that sets approximately the 6 years of age as the beginning of a certain level of abstract thinking and reasoning to solve problems, giving rise to the concrete operational stage after the preoperational stage has finished (Woolfolk, 2006; Ortega, 2005). Something different occurs in the mean results of the relational subtest. The abilities of the areas that this subtest evaluates are already acquired by children of younger age. These children are able to answer correctly most of the tasks, as in the task of matching and classification, which reached the highest mean values, followed by seriation and correspondence tasks. However, based on the theoretical background of the interactionist approach, this could be explained by the design of the Chilean early childhood education curriculum, which focuses its pedagogical work on mathematics in the so-called logic and mathematical relationships and quantification core, whose emphasis is on the progressive development of skills linked to the piagetian pattern, and to a lesser extent to aspects such as counting skills or quantification (MINEDUC, 2001). Thus, in the case of Chile, in actual classroom activities, pre-school educators seem to adjust their teaching planning and their daily learning activities to the abovementioned model. This could explain why pre-schoolers reach higher mean scores on the relational subtest than in the numerical subtest, although this last assumption requires further research.

The findings lead us to suggest that the Chilean preschool education system should consider the timely implementation of remedial mathematics programs in the diagnosed areas to reduce the inequalities that start in the early stages of the schooling process and continue into later stages, perhaps as a result of the socio-cultural and educational context linked to the type of school students attend: public or private. In this regard, previous studies have revealed that children engaged in a program of activities implemented for the development and acquisition of the concept of number reach better levels of mathematical competence that those who follow the traditional curricular model (Cerda, Pérez, Ortega, Sepúlveda & Lleujo, 2011). This is consistent with what other international studies have shown with respect to the positive effects of supplementary programs in mathematics designed to improve the performance of students with previous low academic achievement (Aunio, Hautamäki & Van Luit, 2005; Gersten, Jordan & Light, 2005; Howell & Kemp, 2010; Kroesbergen et al., 2009). This is exceptionally important when longitudinal studies show that early childhood is the time when interventions are more effective, especially with disadvantaged socio-economic groups, particularly in the improvement of reading and math skills (Bulut, 2013; Dyson, Jordan & Glutting, 2011). The absence of remedial actions in this early childhood stage could have a very negative and almost irreversible impact on elementary school students in relation to the learning of mathematics (Toll, Van der Ven, Kroesberger & Van Luit, 2011; Toll & Van Luit, 2013b).

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