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Motivation and mathematics performance: a longitudinal study in early educational stages

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Abstract

This longitudinal study analyzes the predictive value of a set of motivational variables on academic performance in mathematics. Analyses were carried out in a sample of 180 children, with data evaluated in two educational stages (kindergarten and second grade) in formal educational settings. Likewise, baseline differences in motivational and attributional variables in three groups (students with low, average, and high mathematical performance at the end of second grade) are also studied. The results show significant predictive power of self-perceived competence on later mathematics achievement. Persistence, attitude, and the positive attributional dimension of internality make an additional significant contribution. The results also show that the high and low performing groups at the end of second grade presented significant differences at the age of 5 on both self-perceived competence and persistence. In addition, there are differences in persistence between the average and low performance groups. These results are discussed in terms of their theoretical and practical implications.

Keywords: motivation, attributional style, self-perceived competence, persistence, mathematics performance.

Resumen

Se analiza longitudinalmente la capacidad predictiva de un conjunto de variables motivacionales sobre el rendimiento matemático. Los análisis se realizan, en una muestra de 180 niños, con datos evaluados en dos momentos (Educación Infantil 5 años y 2º curso de Primaria). También se estudian las diferencias entre tres grupos (con rendimiento matemático bajo, medio y alto al finalizar el primer ciclo de Primaria) en las variables motivacionales evaluadas en el primer momento. Los resultados muestran un importante poder predictivo sobre el rendimiento matemático posterior de la autocompetencia percibida. También la persistencia, la actitud y la dimensión atribucional de internalidad positiva aportan una contribución significativa adicional. Los resultados muestran igualmente que los grupos con rendimiento alto y bajo al finalizar 2º de Primaria presentaban diferencias significativas a los 5 años, tanto en autocompetencia percibida como en persistencia. Aparecen también diferencias entre los grupos de rendimiento medio y bajo en persistencia. Se discuten las implicaciones teóricas y prácticas de los resultados.

Palabras clave: motivación, estilo atribucional, autocompetencia percibida, persistencia, rendimiento matemático.

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Introduction

Different studies establish a series of skills that seem to be related to mathematics performance and difficulties. These factors can have a specific effect on the development and application of strategies to mathematical tasks, or they can be framed in higher, more general components that influence learning (Passolunghi & Lanfranchi, 2012). Thus, the specific factors would involve basic mathematical skills, such as counting, logical abilities, or numerosity (Desoete & Grégoire, 2006). Some of the general components are cognitive factors, such as IQ or the executive functions of inhibition, working memory, or flexibility, which have been shown to be predictors of mathematics performance throughout the developmental process (Bull & Lee, 2014), evaluated with both neuropsychological measures and ecological ratings (Presentación, Siegenthaler, Pinto, Mercader, & Miranda, 2015).

Current approaches to learning also point to the need to integrate motivational factors in the explanation of mathematics achievement (Op´t Eynde, De Corte, & Verschaffel, 2006; Sarabia & Iriarte, 2011). From this perspective, adequate motivation is necessary for the regulation of cognitive and metacognitive strategies required for significant mathematical learning (Ugartetxea, 2002).

Motivation toward learning is defined as a process that encourages one to learn, that is, a disposition that instigates and maintains interest in the learning elements presented (Pintrich & Schunk, 2006; Wigfield & Eccles, 2002). The relationship between motivation toward learning and mathematics performance is demonstrated with samples of children in elementary school (McKenzie, Gow, & Schweitzer, 2004; Pinxten, Marsh, De Fraine, Van Der Noortgate, & Van Damme, 2014) and high school (Moenikia & Zahed-Babelan, 2010; Suárez-Álvarez, Fernández, & Muñiz, 2014). In children under 7 years old, the research is much more limited, and some authors operationalize this type of motivation based on a set of observable learning behaviors related to effort and students' degree of commitment to a goal in classroom activities (see McDermott, Green, Francis, & Stott, 2000). These studies highlight that initial motivation toward learning contributes not only to immediate mathematics performance (Daniels, 2014), but also to mathematical achievement in higher grades (Ladd, Buhs, & Seid, 2000; Mokrova, O'Brien, Calkins, Leerkes, & Mcrovitch, 2013; Reimann et al., 2013).

The research by McDermott and his collaborators with children from disadvantaged families is especially noteworthy. Their studies show that behaviors that reflect aspects such as perceived self-competence, persistence on errors, or the attitude toward elements of learning in preschool have a special impact on predicting later mathematical performance (Fantuzzo, Perry, & McDermott, 2004; McDermott, Mordell, & Stoltzfus, 2001), considerably increasing the predictive power of general cognitive skills (Yen, Konold, & McDermott, 2004). In fact, these behaviors, especially those related to the initial expectation of success based on perceived competence, appear to be a protective factor against later mathematics learning difficulties (McDermott, Goldberg, Watkins, Stanley, & Glutting, 2006; McDermott et al., 2011). In this regard, the results of a recent study show the sensitivity of initial perceived competence and persistence on difficulties in differentiating between the trajectories of children with and without mathematics achievement problems from preschool to second grade (McDermott, Rikoon, & Fantuzzo, 2014).

In addition, the attributional style is described as people's perceptions of the causes for events that happen to them and others. Weiner (1986) proposes that motivated behavior is influenced by the expectations of achieving a goal and the value given to it, which, in turn, are determined by attributions expressed through personal beliefs about the causes leading to both successes and failures. People can attribute the things that happen to them to internal or external, stable or unstable, and specific or global causes. These dimensions have motivational implications for future behavior and learning. The relationship between attributions and the general learning process has been described in terms of the involvement of attributional feedback in the self-regulation of learning and its outcomes (Pintrich & Schunk, 2006).

Studies carried out with elementary school samples and older samples show that the attribution of success to internal and stable causes seems to determine better school achievement (Miñano & Castejón, 2011). The evidence about situations of failure is clearer. According to Miñano and Castejón (2011), attributions to unstable and controllable causes have been shown to be more adaptive. Therefore, attributing failure to internal, stable, and/or uncontrollable causes has negative effects on future expectations of success (Closas, Sanz de Acedo, & Ugarte, 2011; González, 2005) and the final outcome (Lozano, Pesutti Blanco, & Canosa, 2000).

Additional information is provided by studies that focus on children with mathematics learning difficulties. The majority show that students with a clinical diagnosis of specific disabilities present a greater probability of exhibiting deficits in these motivational and attributional factors. Thus, the review by Miranda, García, Marco and Rosel (2006) concludes that children with specific mathematics learning disabilities, compared to students with adequate mathematics performance, usually show an extrinsic motivational style and attribute their successes and failures less to personal effort. Along these lines, the results of a recent study by Pasta, Mendola, Logonbardi, Prino and Gastaldi (2013) show that students with difficulties (specific or low mathematics and/or reading performance) attribute successes and failures to internal causes to a lesser degree. However, some studies show that this maladaptive attributional style does not seem to be present in all students with learning difficulties (González-Pienda et al., 2000; Núñez et al., 2005).

In conclusion, different studies seem to indicate the importance of motivation toward learning and attributional style variables in mathematics performance and difficulties. However, studies that have tried to evaluate the attributional style have used elementary and high school samples (more than 8 years old). With regard to motivation toward learning, the majority of the studies with preschool children have been carried out within the *Head Start Children* program (Department of Health and Human Services, USA) in families with a low socioeconomic level. It is necessary to continue to explore these motivational aspects using a longitudinal perspective that examines the development of mathematical competence from early educational stages.

Based on the above, the present study aims to analyze the relationship of motivation toward learning and the attributional style with mathematics performance in early educational stages. Specifically, two different objectives are proposed: (a) to analyze the predictive power of motivation toward learning and the attributional style, evaluated in kindergarten, on mathematics achievement in second grade; and (b) to examine the differences in these motivational factors in kindergarten between groups with low, medium, and high mathematics performance in second grade.

Method

Participants

The final study sample is composed of 180 students (51.1% boys; 48.9% girls) from 14 schools in the provinces of Castellón and Valencia (Spain). At time 1 (T1), the participants are aged between 5 and 6 years old (*M* = 70.21 months; *SD* = 3.56 months). At time 2 (T2), the participants are aged between 7 and 8 years old (*M* = 94.16 months; *SD* = 3.78 months). The students present an equivalent mean IQ of 99.28 (*SD* = 12.34), obtained from the *vocabulary* and *block design* subtests of the WPPSI scale (Wechsler, 1996), following the guidelines of Spreen and Strauss (1991). To select the sample, the exclusion criteria used are an equivalent IQ below 70 and the presence on school reports of serious sensorial deficiencies, neurobiological anomalies, psychological disorders, or sociocultural disadvantage. Of the children selected, 87.8% have Spanish nationality, and all of them speak and understand Spanish. In addition, 65% attend public schools, and 35% attend semi-private subsidized schools. Regarding the sociocultural level of the families, 31.1% of the mothers and 37.8% of the fathers have a low educational level (elementary and/or lower secondary obligatory education), 36.1% of the mothers and 34.4% of the fathers have mid-level studies (senior high school and/or vocational education), and 32.8% of the mothers and 27.8% of the fathers have advanced studies (university studies). At T2, 19.1% of the participants attend sessions with specialists in their respective schools: Special Needs (7.7%), Remedial Education (1.9%), Therapeutic Instruction (3.3%), Hearing and Language (3.8%), and combined treatment (2.4%).

For the second objective, the sample is divided into three groups according to the *Mathematics Competence Index* (MCI) obtained on the TEMA-3 test (Ginsburg & Baroody, 2003) in second grade. Thirty-three participants are classified in the low-performing group (LP), 18 of whom obtain an MCI from 70-79 (poor descriptor), and 15 with an MCI < 70 (very poor descriptor). The group with medium performance (MP) is composed of 66 participants, with an MCI of 90-110 (medium descriptor). A third, high-performing (HP) group is composed of 28 participants, 25 with an MCI between 121-130 (high descriptor), and 3 with an MCI > 130 (very high descriptor).

Instruments

T1: Kindergarten, 5 years old

The teachers fill out the *Preschool Learning Behaviors Scale*, (PLBS; McDermott et al., 2000). It contains 29 items grouped in three subscales: *competence-motivation*, which includes behaviors related to the expectation of success (e.g., “Takes refuge in an attitude of impotence”); *attention-persistence*, with items focusing on the capacity to persist on the task until completing it (e.g., “Gets involved in tasks to the degree that would be expected at his/her age”); and *attitude toward learning*, which indicates the will to participate in learning activities, showing a positive attitude toward their elements (e.g., “Shows little interest in pleasing the teacher”). The reliability indicators for the present study are: *competence-motivation*: Cronbach’s alpha (α) = .89, Composite reliability (CR) = .90, Average Variance Extracted (AVE) = .87, McDonald’s Omega (Ω) = .84; *attention-persistence*: α = .85, CR = .86, AVE = .86, Ω = .80; *attitude toward learning*: α = .75, CR = .77, AVE = .77; Ω = .81. The direct score on each subscale is used for the analyses.

In addition, the *Children's Attributional Style Interview,* (CASI; Conley, Haines, Hilt, & Mestalky, 2001) applicable to children from the age of 5 on, is administered individually. On this task, the child is presented with a series of illustrations (16 stories) about events related to achievement. The child has to generate his/her own attributions and rate them in terms of *internality* ("depends on me" vs. "depends on others") *globality* ("happens everywhere" vs. "only happens in one specific scenario"), and *stability* ("happens a lot" vs. "only happens this one time"). Half of the stories are positive, and the rest are negative. The reliability indicators for the test in the present sample are: α = .56, CR = .63, AVE = .59, Ω = .77. The sum of the responses on each index on the questionnaire is taken as reference.

T2: Second grade

To evaluate the mathematics achievement, the Test of Early Mathematics Ability (TEMA-3; Ginsburg & Baroody, 2003) is applied. This standardized test is designed for children from 3 years old to 8 years and eleven months. It is composed of 72 items that assess different aspects of children's mathematical competence. It contemplates both informal aspects (which do not require the use of written mathematical symbols), evaluated with 41 items, and formal aspects (which involve the use of mathematical symbols), evaluated with 31 items. The items are grouped in 8 dimensions: four subscales related to *informal abilities* of *numbering, comparison, calculation, and concepts*; four subscales related to *formal abilities* of *conventionalisms, numerical facts, calculation, and concepts*. The reliability indicators for the present sample are: *informal abilities*: α = .80, CR = .84, AVE = .85; Ω = .60; *formal abilities*: α = .85, CR = .93, AVE = .90, Ω = .76. The present study uses the direct scores on each subscale and the total score. For the second objective, the participants are classified according to the MCI.

Procedure

After obtaining permission from the Board of Education of the Generalitat Valenciana and the approval of the Ethics Committee of Universitat Jaume I to include a range of schools, 6 students per classroom are selected randomly using the simple random sampling technique. The initial sample is composed of 209 kindergartners, of whom 180 participate in the evaluation in second grade (86.6% of the initial sample), thus conforming the final study sample. The evaluation is carried out by professionals from the research team (psychologists and educational psychologists) who are familiar with the application and correction of the tests. Administration is individual and takes place in the mean application time established in the manual and respecting individual rhythms. The physical spaces have adequate conditions of lighting, ventilation, and sound-proofing for the evaluation.

In time 1, the CASI questionnaire (Conley et al., 2001) is administered through an interview with five-year-old kindergarten students, with a mean administration time of 25 minutes. The evaluation takes place in school time, without interfering with significant curricular activities and during the third quarter of the school year. In addition, the teachers fill out the PLBS rating scale (McDermott et al., 2000). The questionnaires are given to the teachers in sealed envelopes and then returned to the researchers.

Two school years later, in T2, the researchers return to the schools and administer the standardized test TEMA-3 (Ginsburg & Baroody, 2003) to the same children, with a mean administration time of 30 minutes, following the same procedure described above.

Data analyses

The Statistical Package for the Social Sciences (SPSS), version 22.00 (SPSS Inc., Chicago, IL USA), is used. For the first objective, multiple linear regression analyses are performed using the step-wise method to find out what motivational behaviors and attributional style dimensions at the age of 5 predict later mathematics achievement in second grade.

For the second objective, multivariate analyses of covariance (MANCOVA) are conducted, introducing equivalent IQ as covariable to establish comparisons between groups with LP, MP and HP in second grade on the motivational and attributional variables evaluated in kindergarten. After testing the proposals, the level of significance is set at.05, and η^2p is calculated to test the strength of the association.

Results

Predictive power of motivation toward learning and attributional style in kindergarten on mathematics performance in second grade

The results in Table 1 show which motivational behaviors evaluated in kindergarten predict mathematics performance in second grade. The variables *competence-motivation* (ΔR^2 = .213, p < .001), *attitude* (ΔR^2 = .049, p = .001), and *attention-persistence* (ΔR^2 = .020, p = .033) predict 28.2% of the total score on the TEMA-3 test (Gingsburg & Baroody, 2003).

With regard to the *informal abilities*, the *numeration* task is predicted by the variables *competence-motivation* (ΔR^2 = .153, p < .001), *attention-persistence* (ΔR^2 = .040, p = .003) and *attitude* (ΔR^2 = .019, p = .044), with a weight of 21.2% of the variance. Only the *competence-motivation* variable predicts 15.1% of the total variance (ΔR^2 = .151, p < .001) on the *comparison* subtest. The *competence-motivation* (ΔR^2 = .123, p < .001), *attention-persistence* (ΔR^2 = .025, p = .023), and *attitude* (ΔR^2 = .022, p = .035) variables explain 16.9% of the variance in calculation. Only the variable *attention-persistence* (ΔR^2 = .128, p < .001) predicts the informal concepts subtest, explaining 12.8% of the variance.

In the case of the *formal abilities*, the *competence-motivation* variable predicts 12.6% of the variance in the *conventionalisms* subtest (ΔR^2 = .126, p < .001). The *competence-motivation* variable also explains 18.5% of the variance in the *numerical facts* subtest (ΔR^2 = .185, p < .001). The results obtained for *calculation* are predicted by *attention-persistence* (ΔR^2 = .213, p < .001) and *attitude* (ΔR^2 = .050, p = .001), which explain 26.3% of the total variance. Finally, 17.7% of the variance in the *formal concepts* variable is explained by *competence-motivation* (ΔR^2 = .133, p < .001), *attention-persistence* (ΔR^2 = .025, p = .022), and *attitude* (ΔR^2 = .019, p = .046).

Table 1
Regression analyses of the subscales of the Preschool Learning Behaviors Scale (PLBS; McDermott et al., 2000) on the mathematical achievement measures (TEMA-3; Ginsburg & Baroody, 2003)

	Motivation toward learning			
	F	R^2	ΔR^2	Beta
Total score				
Competence-Motivation			.213	.243
Attitude			.049	-.319
Attention-Persistence	23.02**	.282	.020	.489
Informal Numbering				
Competence-Motivation			.153	.245
Attention-Persistence			.040	.404
Attitude	15.80**	.212	.019	-.327
Informal comparison				
Competence-Motivation	31.77**	.151	.151	.389
Informal calculation				
Competence-Motivation			.123	.260
Attention-Persistence			.025	.318
Attitude	11.94**	.169	.022	-.303
Informal concepts				
Attention-Persistence	26.15**	.128	.128	.358
Formal conventionalisms				
Competence-Motivation	25.61**	.126	.126	.355
Formal numerical facts				
Competence-Motivation	40.31**	.185	.185	.430
Formal calculation				
Attention-Persistence			.213	.692
Attitude	31.65**	.263	.050	-.321
Formal concepts				
Competence-Motivation			.133	.268
Attention-Persistence			.025	.319
Attitude	12.63**	.177	.019	-.293

* $p < .05$; ** $p < .001$

Table 2 presents the results of the stepwise multiple linear regression analysis for the attributional variables in kindergarten compared to the mathematical skills evaluated two years later.

The *internality* for positive events variable is the only statistically significant predictor of the scores obtained on the different mathematical achievement subtests, with variances ranging between 2.2% and 4.1%. The significant results obtained on the linear regression analysis of the informal tests are: total score ($\Delta R^2 = .041$, $p = .006$), *numeration* ($\Delta R^2 = .035$, $p = .012$), *comparison* ($\Delta R^2 = .030$, $p = .019$), *calculation* ($\Delta R^2 = .033$, $p = .015$), and *concepts* ($\Delta R^2 = .034$, $p = .013$); and of the formal tests: *numerical facts* ($\Delta R^2 = .034$, $p = .014$), *calculation* ($\Delta R^2 = .031$, $p = .018$) and *concepts* ($\Delta R^2 = .022$, $p = .046$).

Table 2
Regression analyses of the dimension of attributional style (CASI; Conley et al., 2001) on the mathematical achievement measures (TEMA-3; Ginsburg & Baroody, 2003)

	Attributional Style			
	F	R^2	ΔR^2	Beta
Total score				
Positive internality	7.61*	.041	.041	.203
Informal numeration				
Positive internality	6.45*	.035	.035	.187
Informal comparison				
Positive internality	5.56*	.030	.030	.174
Informal calculation				
Positive internality	6.07*	.033	.033	.182
Informal concepts				
Positive internality	6.36*	.034	.034	.186
Formal conventionalisms	n.s.	-	-	-
Formal numerical facts				
Positive internality	6.22*	.034	.034	.184
Formal calculation				
Positive internality	5.72*	.031	.031	.176
Formal concepts				
Positive internality	4.03*	.022	.022	.149

* $p < .05$; ** $p < .001$.

Differences in motivational factors between groups with and without mathematical achievement problems in second grade

Table 3 shows the differences in the motivational and attributional variables evaluated in kindergarten for the groups with LP, MP and HP in second grade. The equivalent IQ is introduced as co-variable, given that statistically significant differences are found between the groups [$F(2,124) = 8.94$, $p < .001$, $\eta^2p = .126$].

The main effect of group is statistically significant for the motivation toward learning variables [Wilks' Lambda (ʌ) = .82, $F(6,244) = 4.15$, $p = .001$, $\eta^2p = .093$]. The confirmation ANCOVAs reveal statistically significant differences in the *competence-motivation* [$F(2,123) = 3.63$, $p = .029$, $\eta^2p = .056$] and *attention-persistence* [$F(2,123) = 8.17$, $p < .001$, $\eta^2p = .117$] variables. No differences are found in the *attitude* variable. The a posteriori pairwise comparisons show statistically significant differences between the LP and HP groups on the *competence- motivation* ($p = .024$) and *attention-persistence* ($p < .001$) variables. Differences are observed between the LP and MP on the *attention-persistence* variable ($p = .008$).

In the case of the attributional variables, the main effect of group does not reach statistical significance [Wilks' Lambda (ʌ) = .93, F (2,236) = .775, $p = .676$, $\eta^2p = .038$].

Table 3
Comparison of means analysis of the LP, MP, and HP groups on motivation toward learning (PLBS; McDermott et al., 2000) and attributional style (CASI; Conley et al., 2001)

	LP *n* = 33	MP *n* = 66	HP *n* = 28			Diff. bet. groups
	M (*DT*)	*M* (*DT*)	*M (DT)*	*F* (2,123)	η2p	
PLBS						
Competence-Motivation	16.18 (3.94)	18.09 (4.91)	20.68 (1.81)	3.69*	.056	HP>LP
Attention-Persistence	10.85 (3.42)	13.74 (4.38)	15.93 (2.29)	8.17**	.117	HP>LP MP>LP
Attitude	11.55 (2.21)	12.33 (2.20)	12.54 (2.70)	.571	.009	-
CASI						-
Positive internality	4.67 (1.14)	5.27 (1.24)	5.50 (1.50)	2.07	.033	-
Positive stability	5.64 (2.16)	6.27 (1.78)	6.29 (2.12)	.793	.013	-
Positive globality	6.09 (1.73)	6.55 (1.31)	6.68 (1.25)	.564	.009	-
Negative internality	3.64 (1.59)	3.42 (1.60)	3.57 (1.50)	.239	.004	-
Negative stability	3.61 (2.47)	3.52 (2.56)	3.25 (1.60)	.368	.006	-
Negative globality	4.39 (2.21)	4.74 (2.05)	4.57 (2.50)	.251	.004	-

Note. LP = Low Performance; MP = Medium performance; HP = High performance.
*$p < .05$, **$p < .001$.

Discussion

The first objective is to explore the predictive power of motivation toward learning and attributions, evaluated in kindergarten, on mathematics abilities in second grade. In the present study, motivation toward learning is measured through the teachers’ responses to questions about aspects related to perceived self-efficacy beliefs, persistence, and attitude, thus showing the multidimensionality of the aspects included in interest in learning (Wilson & Trainin, 2007). The results show their significant weight in predicting all the mathematical skills analyzed, with variances ranging, together, between 12.6% and 28.2%. In addition, the weight of these variables is slightly greater on the scores obtained on formal math skills, which involve the use of written mathematical symbols (developed in school contexts), an aspect that can be related to the good work of the professionals in this educational stage.

The student’s self-competence is the predictor that best explains mathematical performance on the majority of the variables analyzed. Likewise, persistence and attitude toward learning make an additional, but smaller, significant contribution. The especially significant weight of persistence in predicting calculation operations with arithmetic formulas stands out. These results coincide with those from research with older students (McKenzie et al., 2004; Moenikia & Zahed-Babelan, 2010; Pinxten et al., 2014; Suárez-Álvarez et al., 2014), and they suggest that the presence of a positive academic self-concept and a persistent orientation toward learning in kindergarten has an influence on future academic goals and achievements (Daniels, 2014; Fantuzzo et al., 2004; Ladd et al., 2000; McDermott et al., 2001; Mokrova et al., 2013; Reimann et al., 2013).

Continuing with the first objective, when evaluating the predictive value of the attributional style dimensions, only the positive internality dimension shows a significant weight on academic achievement, although with limited values. The present study shows that, in kindergarten, the attributions seem to be in an initial stage, characterized by not being very stable and a tendency to attribute academic successes to internal factors, whereas failures are still explained inconsistently in all the dimensions analyzed. Future studies will have to examine this question more in depth.

The results obtained for the first objective coincide with studies carried out with older samples, showing that motivational and attributional variables act as predictors of academic performance (Miñano & Castejón, 2008; 2011). However, the variances obtained in these previous studies are higher than those obtained in the present study. These differences are probably due, in addition to the instruments used, to the age difference between the two samples, with quite different degrees of maturity, interests, and perceptions of self-competence. This fact would indicate that the weight of motivation on academic performance increases with age. One of the main contributions of the present study is that it highlights that, although less than in other educational stages, motivational variables already play a significant role in kindergarten that must be taken into account.

The second objective is to study which motivation toward learning and attributional variables, evaluated in kindergarten, differ in second-grade students with low, medium, and high academic performance. With regard to the former, students with low performance in second grade, compared to those with high performance, show, in their teachers' opinion two years earlier, fewer behaviors of perceived self-competence and persistence when faced with difficulties. This result agrees with studies that highlight the importance of self-competence as a protective factor from later difficulties (McDermott et al., 2006; McDermott et al., 2011).

Persistence in kindergarten is also the variable that differentiates between the low and medium performance groups at the end of second grade. The importance of persistence in the adequate development of academic learning and its difficulties is also reflected in the study by Mokrova et al. (2013) with younger students. Using a longitudinal design, these researchers find that, independently from demographic factors and cognitive-linguistic skills, boys and girls who are more persistent in completing a challenging task at the age of 3 show better academic skills (in language and mathematics) two years later. Finally, there are no significant differences between the mathematics performance groups in their attributional style. However, comparisons of means show a tendency in the relationship between mathematical performance and positive internality.

In summary, the results obtained show that, in kindergarten, the motivation toward learning variables and, to a lesser degree, the attributions, influence future achievement. Furthermore, in the line of study of McDermott et al. (2014), it seems that perceived self-competence and persistence on tasks are variables that should be taken into account in explaining the appearance of later mathematics achievement difficulties.

The present study is the first to demonstrate the combined importance of early motivation toward learning and attributional style variables in later mathematics performance. However, future studies should incorporate other procedures to evaluate motivation through the student and other people around him/her. Another study limitation is the absence of other explanatory variables for mathematics performance of a personal (cognitive, executive functioning, etc.) and contextual nature, both socioenvironmental and institutional and instructional (Bull & Lee, 2014; Op´t Eynde et al., 2006). Longitudinal studies are needed to more closely examine the results of this study. Likewise, future studies should be designed to determine what individual and contextual factors lie behind motivation, especially in students with poor academic results.

One of the practical applications emerging from the study is the need to incorporate, from kindergarten stage, motivational components to train both students and teachers. It is important to provide kindergarten teachers and family members with information about the role of motivation in academic success, and how to develop motivation in their students/children, especially in students at risk of experiencing difficulties. As a recent meta-analysis points out, increased motivation is one of the factors that condition the efficacy of interventions for students with mathematics difficulties (Ise & Schulte-Körne, 2013).

Families and teachers should provide learning environments that emphasize autonomy rather than external control. When learning is achieved through procedures that support the child's involvement, a feeling of self-determination is fostered, as well as the comprehension of the material to be learned. Families and teachers must accompany the child in the learning process by transmitting their passion and enthusiasm for knowledge, and by strengthening feelings of academic self-competence as the basis for educational success.

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