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SEÇÃO: ARTIGO

Executive performance and mathematic learning difficulties: Association with sociodemographic aspects

Desempenho executivo e dificuldades de aprendizagem em matemática: associações com aspectos sociodemográficos

Desempeño ejecutivo y dificultades en el aprendizaje de las matemáticas: Associaciones con aspectos sociodemográficos

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Abstract: Considering the association between Executive Functions (EF) and performance in mathematic, we aimed to analyse the low executive functions – which impact the individual's personal, social, and educational functioning –, and their associations with this performance and sociodemographic aspects not already explored in students aged 8 to 12 years. One hundred and ten participants were evaluated using the MMSE, Coruja PROMAT, NEUPSILIN-INF, FDT and a Sociodemographic Questionnaire. Correlation and regression analysis indicated that low executive accomplishment influences performance in mathematics, especially considering working memory and cognitive flexibility. The variables gender, family income and parents' age were not related to the presentation of low EF. In contrast, the sociodemographic aspects of school shift and parents' education were shown to be related to executive performance, especially among public school students, revealing the importance of attention to these factors.

Keywords: executive functions, mathematical performance, dysfunctions, sociodemographic factors

Resumo: Considerando a associação entre Funções Executivas (FE) e desempenho em matemática, objetivou-se analisar a baixa performance executiva – que impacta o funcionamento pessoal, social e educacional do indivíduo –, e suas associações com esse desempenho e aspectos sociodemográficos ainda não explorados em escolares de 8 a 12 anos. Foram avaliados 110 participantes de ambos os sexos a partir dos instrumentos MEEM, Coruja-PROMAT, NEUPSILIN, FDT e Questionário Sociodemográfico. As análises de correlação e regressão empreendidas indicaram que o baixo desempenho executivo exerce influência sobre o desempenho em matemática, especialmente considerando a memória de trabalho e a flexibilidade cognitiva. As variáveis sexo, renda familiar e idade dos pais não apresentaram relação com baixa FE. Em contraponto, os aspectos sociodemográficos turno escolar e escolaridade dos pais se demonstraram fortemente relacionados à baixa performance executiva, especialmente nos estudantes de escola pública, revelando a importância da atenção a esses fatores.

Palavras chaves: funções executivas, desempenho matemático, disfunções, fatores sociodemográficos

Resumen: Considerando la asociación entre Funciones Ejecutivas (FE) y desempeño en matemáticas, objetivamos analizar la baja performance ejecutiva - que impacta en el funcionamiento personal, social y educativo del individuo - y sus asociaciones con este desempeño y aspectos sociodemográficos no explorados en escolares de 8 a 12 años. Ciento y diez participantes de ambos sexos fueron evaluados utilizando lo MEEM, Coruja-PROMAT, NEUPSILIN, FDT y Cuestionario Sociodemográfico. Los análisis de correlación y regresión indicaron que el bajo rendimiento ejecutivo influye en el rendimiento en matemáticas, especialmente considerando la memoria de trabajo y la flexibilidad cognitiva. Las variables

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sexo, renta familiar y edad de los progenitores no se relacionaron con baja FE. Por el contrario, los aspectos sociodemográficos turno escolar y educación de los progenitores estaban fuertemente relacionados con el bajo desempeño ejecutivo, especialmente en los estudiantes de escuelas públicas, revelando la importancia atención a estos factores.

Palabras clave: funciones ejecutivas, rendimiento matemático, disfunciones, factores socieodemográficos

The mastery of mathematical skills is essential in the most diverse situations of daily life, so that day-to-day we make decisions based on numerical information, such as the change and bank accounts conference and the understanding of statistical data and news about economics (Weinstein, 2016). In this direction, a growing body of research suggests that mathematical skills are essential for long-term school success, as well as for positive results in other areas of life, such as professional and relational (Pace et al., 2019; Watts et al., 2018). However, it is well known in the literature that the performance in mathematics of brazilian students in the early years is precarious, with the discourse of families, teachers and the instruments of external evaluation proving the learning gap and the students' difficulties in front of the most elementary contents of this curricular component (Silva, 2017; Silva & Coutinho, 2019).

Difficulties in mathematical learning are characterized by deficits in the notions of numerical meaning, in the memorization of arithmetic facts, difficulties in carrying out precise or fluent calculations and imprecise mathematical reasoning (American Psychiatric Association, 2014). In this context, the causes for the difficulties in learning mathematics are the most distinct, involving cognitive functions such as the visuospatial, phonological skills, attention, language and executive functions, so as to demand the establishment of more precise relationships between the social, neural and cognitive factors necessary for the execution of numerical activities is demanded (Peng et al., 2018).

Students who have specific learning difficulties (SpLD), such as learning difficulties in mathematics, exhibit weaknesses in specific processes, instead of a global intellectual disability, allowing to infer that each academic and cognitive component has a distinct signature in the human brain (Grigorenko et al., 2020). Thus, it is understood that these signatures and etiologies overlap, because they are correlated, but are not equivalent, as their unique characteristics substantiate the distinction between the various modalities of learning difficulties (Grigorenko et al., 2020; Spencer et al., 2019).

In this sense, it is legitimate to question what are the specific factors related to poor school mathematical performance. From the perspective of Neuropsychology, recent research stands out emphasizing the relationship between mathematical performance and injuries, disorders and specific cognitive skills (Grant et al., 2020; Mahmud et al., 2020). However, the etiology of a SpLD is complex, involving neural structures, genetic and also environmental factors, as stated Grigorenko et al., (2020) in a literature review. In this way, several researchers have been studying mathematical learning under different approaches, such as social, cognitive and genetic (Grigorenko et al., 2020; Hoyles, 2002; Willcutt et al., 2010).

Thereby, in the field of Cognitive Psychology, brazilian research on mathematics practiced outside the school context gained worldwide prominence as they sought to understand the relationship between the various forms of mathematical knowledge and the meanings of this matter (e.g., Carraher et al., 1982). Internationally, some authors have focused on analyses of the perception of students' affection for mathematics, teachers and mathematics classes (Van Mier et al., 2019).

Therefore, considering the diversity of approaches to mathematical learning, we emphasize that in order to understand it, as well as to understand the difficulties related to it, it's not possible to reduce all its complexity to one conditioning factor. Corroborating Oliveira et al. (2015), it is possible to point out that mathematical performance depends on internal and external conditions, such as brain and cognitive functioning, spoken language, learning style, sociocultural and economic factors, as well as teaching methods. In this direction, and in agreement with Grigorenko et al. (2020), we understand the mathematical ability as a complex skill whose execution requires the collaboration of a number of interacting components, executive skills being one of those factors that influence performance in mathematics.

Executive Functions (EF) are complex high-level cognitive skills associated with self-management of behaviors, recognized as being related to organization, task planning and intentional cognitive action (Willoughby et al., 2019). According to a systematic review, current research has explored the relationship between EF and its contributions to learning, with associations between these skills and academic success in reading and arithmetic (Santana et al., 2019).

The slow pace, dependencies on environmental stimulation and of a variety of basic cognitive skills are said to make executive development extremely vulnerable to dysfunction (Garon et al. 2008). The concept of executive dysfunction encompasses deficits or low performance in one or more components of EF, and individuals with such dysfunctions have disabilities in controlling impulses, monitoring intentional behaviors and achieving goals, as well as demonstrating perseverative verbal and motor behavior (Gazzaniga et al., 2006). Some research indicates that poor executive performance may be related to disorders, disabilities, traumas and syndromes such as Attention Deficit Hyperactivity Disorder (ADHD), Rett Syndrome, Dyslexia, Williams and Down Syndromes (Miklós et al., 2019; Santana et al., 2019).

Difficulties related to executive functioning can compromise attentional control, memory, and the adequacy of behaviors, impact the learning of new information and content and, consequently, influence academic performance (Andrade et al., 2016). Thus, it is noteworthy that the main elements evaluated in studies that related EF to the learning process are metacognition (e.g., Bellon et al., 2019), reading skills (e.g. Follmer, 2018), writing (e.g. Berninger et al., 2017) and mathematics (e.g. Cragg et al., 2017), being the last one the focus of this study.

In this sense, it is understood that EF are important skills for a good performance in mathematics, however, research focused specifically on the association between low executive performance and learning difficulties related to mathematics are not found (Santana et al., 2019; Cragg et al., 2017). Studies claim that basic executive components such as Inhibitory Control (IC), Working Memory (WM) and Cognitive Flexibility (CF) are associated with mathematical learning (Chamandar et al, 2019; Purpura et al., 2017). Corroborating, Desoete and Weerdt (2013) highlight the association of WM with mathematical learning difficulties, however, the relationship between the low in the three basic EF (WM, CF and IC) and performance in mathematics is not directly explored.

In addition, the importance of the interaction between low executive performance, mathematical performance and environmental aspects, although recognized by the literature (e.g. Grigorenko et al., 2020), has also not been explored scientifically, with the following questions remaining: Is there a relationship between low scores on EF tasks and poor math performance? Is low executive functioning influenced by environmental factors such as parents' income and education? Is there an association between sex and executive performance?

Based on the available literature on the topic and the gaps still found in this field of research, this study aimed to evaluate the interaction between EF, performance in mathematics and sociodemographic aspects in students aged 8 to 12 years. For this purpose, we considered the variables sex, school shift (class schedule of participants), family income, education and age of parents.

Method

Participants

The sample of this study was composed of 110 participants selected from the stratified probability sampling method, including students regularly enrolled from the 2nd to the 7th year of elementary school, equally distributed between 8 and 12 years of age, of both sexes (50.9 % female and 49.1% male) from public and private schools (54.5% public and 45.5% private) in the city of Recife, Pernambuco state in Brazil. About the family income, 55 (58.4%) participants received up to 2 thousand reais (brazilian currency), 29 (26.2%) between 3 and 4 thousand, 12 (7.1%) between 5 and 6 thousand and 14 (8, 3%) between 7 and 8 thousand. As for the parents' education, 72 (65.8%) had only studied up to high school and 38 (34.2%) had completed an undergraduate degree. The study excluded (1) students who did not have preserved or corrected neurological, auditory, oral and visual functioning, (2) with special educational needs and or (3) with severe cognitive losses. The information necessary for inclusion or exclusion was acquired from the school record of each student, from the application of the Mini-Mental State Examination - MMSE (Jain & Passi, 2005) and from a sociodemographic questionnaire.

Instruments

Participants were assessed by applying five instruments, considering their respective manuals for correction. Aspects of sociodemographic variables were assessed using a Sociodemographic Questionnaire, specifically designed for the present study. One of the parents or guardians of the participating student was asked to provide information such as: age, family income, parental education, among others reported in the results. The cognitive impairments, which indicated the inclusion or not of participants in the sample, were assessed using the MMSE, with the adaptation for individuals aged 3 to 14 years proposed and validated by Jain and Passi (2005). The MMSE evaluates the mental functions of language, spatial and temporal orientation, attention, memory and constructive praxis.

The performance in mathematics was assessed using the Mathematical Skills Survey Roadmap - Coruja PROMAT- (Roteiro para Sondagem de Habilidades Matemáticas, Weinstein, 2016), which is an instrument validated for use in brazilian children aged 6 to 13 years. The areas evaluated by the test are: 1) Representation of the numerical magnitude; 2) Evocation of basic numerical or arithmetic facts; and 3) Problem-solving.

Considering the executive components, the Working Memory was assessed based on the application of the Child Neuropsychological Assessment Instrument - NEUPSILIN-INF (Instrumento de Avaliação Neuropsicológica Breve Infantil, Salles et al., 2016), which has apparent and content validity for the assessment of children aged 6 to 12 years. The NEUPSILIN-INF examines WM in specific tasks from sequences of words in the direct order, digits in the indirect order and span of pseudowords. Finally, we used the psychological instrument Five Digit Test -FDT (Teste dos Cinco Dígitos, Sedó et al., 2015) for the evaluation of the executive components Inhibitory Control and Cognitive Flexibility. The FDT is a recognized, standardized and validated test for individuals aged 6 to 92 years old that uses conflicting information about numbers and quantities.

Ethical and data collection procedures

The research protocol was approved by the Research Ethics Committee of the Federal University of Pernambuco, favorable opinion number 3.969.380 (CAEE: 09704119.4.0000.5208), as well as the participants were fully informed about the objectives and procedures of the study prior to signing Terms of Consent and Assent. After these procedures, the data collection was carried out in public and private schools in the city of Recife in 2019 through the application of the aforementioned instruments to individuals who met the inclusion criteria. The data collection was performed in an individual session according to the availability and consent of the participants.

Data analysis procedures

In order to compare different groups by performance in mathematics, the total sample of participants was divided into two groups, namely: low and high performances in mathematics, considering the Coruja- PROMAT test score for both. In addition, to the distribution of participants by levels of performance in EF, we created two groups, low and high performances in each of the

EF, considering for this division the scores in the NEUPSILIN-INF and FDT tests. It is noteworthy that the groups formed were found to be significantly different from the statistical point of view (Mann-Whitney U test: for performance in mathematics U = 77,000 and p <0.001; working memory U = 12,000 and p <0.001; inhibitory control U = 0.001 and p <0.001; cognitive flexibility U = 2.500 and p <0.001). Statistical analyses of point-biserial (r_{pb}) and Phi correlation were performed, as well as logistic regression analyses. We also point out that for the execution of the regressions the prerequisite for the absence of multicollinearity was met (tolerance values greater than> 0.1 and VIF <10).

Results

Participants had a mean math performance of 85 points (SD=13.8; min=42 and max=100), in working memory of 65 (SD=9.1; min=15 and max=76), in inhibitory control 36 (SD=11.6; min=0 and max=62) and in cognitive flexibility of 60 (SD=15.4; min=0 and max=88). The results of the statistical analyses carried out showed associations between the low performance in mathematics and the three basic executive components, with the correlation of greater magnitude established between low working memory and low performance in mathematics (Corr.=0.438; p <0.001), followed by the components cognitive flexibility (Corr = 0.382; p <0.001) and inhibitory control (Corr = 0.273; p <0.001). In addition to the association between low executive performance and mathematics in general, negative correlations were observed between good results in all specific areas of mathematical performance assessed and low EF. The emphasis is again on WM, a component that showed correlations of greater magnitude with the areas of representation of numerical magnitude, numerical fact, problem-solving and resolution time. In addition to the correlations with the WM, those between CF and numerical fact, CF and resolution time, and between the IC and the notions of numerical fact, noted in Table 1, stood out.

Table 1 – Correlations between Low Mathematics Performance, Specific Mathematics Areas and Low Executive Performance

Math		Low Executive Functioning		
		WM	**CF**	**IC**
Low Mathematical Performance	Corr.	438[1]	382[1]	, 273[1]
	p	*, 001*	*, 001*	*, 004*
Numerical Magnitude	Corr.	-, 480[2]	-, 384[2]	-, 314[2]
	p	*, 001*	*, 001*	*, 001*
Numerical Fact	Corr.	-, 476[2]	-, 401[2]	-, 341[2]
	p	*, 001*	*, 001*	*, 001*
Problem-solving	Corr.	-, 475[2]	-, 371[2]	-, 242[2]
	p	*, 001*	*, 001*	*, 011*
Resolution Time	Corr.	-, 360[2]	-, 391[2]	-, 248[2]
	p	*, 001*	*, 001*	*, 001*

Note: [1] phi correlation, [2] point-biserial correlation.

From the statistical analysis of logistic regression, in order to verify the predictive value of the decrease in EF on the performance in mathematics, it was observed that the low executive performances in the three components separately (considered as step 1) predict part of the performance in mathematics, as can be seen in Table 2. We can note that the three models present a significant percentage of cases that fit on them, with a higher percentage of cases

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adequately classified by the model with WM (72.7%), followed by CF (69.1%) and IC (63.6%) (95% confidence interval).

Table 2 – Logistic Regression Analysis considering as independent variables each EF separately and dependent variable the Performance in Mathematics

	B	S.E	Wald	p	% correct	R^2 Nagel.	R^2 Cox & Snell	Exp(B)
WM. Step 1								
WM. Low	1,962	, 428	20.99	, 001	72.7	, 257	, 193	7.111
Constant	, 000	, 214	, 000	1,000				1,000
CF. Step 1								
CF. Low	1.609	, 413	15.19	, 001	69.1	185	139	4,997
Constant	, 000	206	, 000	1,000				1,000
IC. Step 1								
IC. Low	1,119	396	7.97	, 005	63.6	097	, 073	3,062
Constant	-, 560	280	3.98	, 046				571

However, considering a forward stepwise logistic regression model that includes the three components together, in stages, shown in Table 3, it appears that even adding the IC as the first step, it is excluded from the equation, with WM and CF remaining. Adding the CF as a step before the WM and this as the last step, the permanence of the two EF is observed, still with emphasis on the WM. Considering the odds ratio, it is observed that the subjects with low WM are 7 times more likely (Exp (B) = 7.111 and p< 0.001) to present low performance in mathematics than those who present a good performance in WM (confidence interval of 95%).

Table 3 – Logistic Regression with fixed order with Mathematics as the dependent variable and two statistical models as independent, always with WM as the third step

MODELS	B	S.E	Wald	p	% correct	R^2 Nagel.	R^2 Cox & Snell	Exp (B)
WM. Step 1								
WM	1,962	, 428	20.99	, 001	72.7	, 257	, 193	7.11
Constant	, 000	, 214	, 000	1.00				1.00
WM. Step 2								
CF	1.301	, 448	8,453	, 004	72.7	339	, 254	3.67
WM	1,724	, 448	14.83	, 001				
Constant	, 000	223	, 000	1.00				1.00

Considering the influence of low executive performance in determining mathematical performance, already identified, it is important to explore the relationships of these losses in EF with some specific variables on which there is no consensus, such as the gender variable (See table 4). In the case of the latter, it appears that sex does not predict low executive performance in any of the components. The same is possible to infer about the family income and the age of the person responsible for the child, who did not show statistically significant correlations with any of the components of the executive triad (p> 0.05).

Table 4 – Correlations between low executive performances and sociodemographic variables

Executive Components		Full Time Public School	Full Time General	Age Resp.	Income	Education General	Sex
WM. Low	Corr.	**-, 331[1]**	-, 162[1]	, 0.78[2]	, 190[2]	, 087[2]	, 036[1]
	p	***, 010***	*092*	*.489*	*083*	*434*	*706*
CF. Low	Corr.	, 031[1]	-, 063[1]	, -071[2]	, 204[2]	**-, 244[2]**	, 073[1]
	p	*.814[1]*	*.512*	*.529*	*063*	***, 026***	*450*
IC. Low	Corr.	135[1]	063[1]	, 089[2]	, 008[2]	, 017[2]	, 036[1]
	p	***, 304***	***.512***	***.430***	***944***	***.882***	***706***

Note: [1] phi correlation, [2] point-biserial correlation.

In contrast, the variable education of parents is correlated with poor performance in CF (Corr. = -0.244; p <0.05), revealing that parents, specifically those with a higher level of education, have an influence on the performance in CF and, consequently, in mathematics. Finally, the variable school shift, specifically full time, showed a significant negative correlation with the low WM (Corr. = -0.331; p <0.05), standing out even considering that the sample of participants who study full-time included is minimal, corresponding to 9% of the total.

Discussion

This study aimed to evaluate the interaction between EF and performance in mathematics of schoolchildren between 8 and 12 years old, considering the low executive performance and its associations with sociodemographic aspects. In this sense, there was a significant interaction between low executive performance and low performance in mathematics, especially with regard to the Working Memory (WM) component. Therefore, recent research on the relationship between WM and mathematics indicates that this executive skill mediates school mathematical performance (e.g., Justicia-Galiano et al., 2017; Li & Geary, 2017; Miller et al., 2018).

Specifically, it was evidenced that the low performance in WM represents difficulties for students in all areas of mathematics evaluated in this study, causing impacts on the skills of comparing non-symbolic numerical quantities, combining basic operations and solving oral and written problems, which implies in a lack of knowledge of semantic construction and mathematical relations. Considering that WM is a necessary function for ordering information, translating instructions into action plans and incorporating new information (Diamond, 2013; Miller et al., 2018), the low performance in WM impairs the student in the tasks that require the understanding and ordering of more than one mathematical operation, such as the use of addition and multiplication in the context of the same problem.

In this sense, it is understood that low performance in working memory significantly affects students' mathematics performance, with the unsatisfactory performance in this component associated with losses in math tasks, as stated by Desoete and Weerdt (2013). Simmons et al. (2012) emphasize that WM is directly related to primitive math skills and numerical writing, which have been essential to regular performance since the beginning of school life. It is also pointed out that the difficulties associated with WM in children alter the ability to process information and integrate it, also leading to difficulties in more complex processes, such as following more elaborate instructions, which can influence the non-fulfillment of tasks or activities until the end (León et al., 2013).

In addition to WM, associations of low scores in Cognitive Flexibility (CF) and Inhibitory Control (IC) with performance in mathematics were highlighted. In this direction, links between initial IC skills and subsequent mathematical performance suggest the possibility that IC will play a significant role in this performance (Choi et al., 2018). With regard to CF, it is pointed out that this function is related to abstract mathematical skills, being also relevant to students' performance in this discipline (Purpura et al., 2017). Therefore, as Diamond (2013) stated, without inhibitory control, we would be at the mercy of old habits, impulses, thoughts, and actions, conditioned by the environment's stimuli that pull us here or there. Meanwhile, deficits in cognitive flexibility promote perseverative behaviors, that is, repeated behaviors, despite their apparent lack of effectiveness (León et al., 2013).

Thus, we note that difficulties in changing strategies, linked to the performance of CF, and in controlling impulses, associated with IC, impair performance in mathematics, leading to perseverance in errors and difficulties in concentrating on the objectives proposed in mathematical problems. It is noteworthy that these components showed negative correlations of greater magnitude with the skills of comparing quantities and with the resolution time, which means that students with low performance in CF and IC have difficulties in the quick and efficient execution of basic mathematical activities, which imply in the ability to order objects, recognize the number of points in a set and even to enumerate.

It was evidenced that the decrease in each executive component predicts a certain portion of the low performance in mathematics, again with an emphasis on the predictive value of WM, followed by CF and IC. However, when considering the three components together, there is a drop in the importance of low IC in determining low performance in mathematics. In contrast, even considering the three components together, the CF remains to determine the performance in mathematics, emphasizing the importance of a strategic and flexible mind for an efficient mathematical calculation. In this sense, Hazin et al. (2009) state that children with high skills / giftedness have specific cognitive skills that directly impact good school mathematical performance, which are verbal memory and cognitive flexibility. Thus, when analyzing the other extreme, the present study emphasizes that the low capacity to develop strategies never before thought and to make thinking flexible to allow adaptation to new challenges leads to unsatisfactory mathematical performance.

In general, and in line with Oliveira and Nascimento (2014), it is indicated that individuals with low executive functioning have inefficient reasoning, difficulties related to the ability to change their focus mentally, and problems in planning and learning from mistakes. Thus, good performance in mathematics depends on success in EF and there is currently a growing body of evidence demonstrating how much basic executive functions and performance in mathematics are connected (Cragg et al., 2017).

Regarding the association between low executive performance and some specific variables, the interaction between EF and sex is highlighted, which has already been explored in previous studies, but on which there is no consensus. Ferreira et al. (2015), for example, highlight that in the research undertaken by them no significant differences are observed between boys and girls in executive performance, however, they mention that in international studies this difference was observed, with no consensus whether girls or boys perform best in tasks that assess EF. With regard to this study, it was evidenced that gender does not predict low executive performance in any of the components, as well as family income and the age of the person responsible for the child. Furthermore, it is noteworthy that just as gender is not significant in determining executive functioning, neither is it in determining performance in mathematics, further reinforcing the conclusion that executive performance is associated with performance in mathematics.

In contrast, parents' education correlated explicitly with CF performance, revealing that parents with a higher education level influence their children's CF performance and, consequently, in mathematics. Regarding this sociodemographic factor, studies have already identified that the educational structure of the family influences academic performance at the elementary school level (e.g. Martins et al., 2017), high school level (e.g. Silva et al., 2017) and higher education level (e.g. Brandt et al., 2020). However, there was still no data regarding the influence of parents' education on executive performance.

In this sense, it is understood that parents with a higher level of education positively influence their children's executive development, specifically their performance in CF. Such a result can be associated with the encouragement and help provided by parents in solving problems and identifying alternative strategies when the student's initial plan is not successful. Corroborating, Guerreiro-Casanova et al. (2011), emphasize that students from families with better educational resources experience environments that encourage the belief in academic self-efficacy, which allows more positive experiences, enriching teaching, expanding possibilities and opening space for the use of new strategies.

In addition to the influence of parents' education in determining low and high executive performance, we highlight the variable full time school, which despite the small sample size of students enrolled in this type of education has proved to be relevant, specifically in determining WM. Therefore, it can be understood from this result that full-time students have better development of WM, an important facilitator of the mathematical learning process.

It is emphasized that the proposal for full-time education aims to contribute to the improvement of learning by extending the length of stay of basic education students in schools (Bernardo, 2020). In this direction, the so-called "school effect" stands out, which has explained great differences in student performance. In view of the various factors that cause the school effect, time is one of the most consistent in research, which has been demonstrated that there is no automatic and direct association between more time and better performance or vice versa. However, it finds that the longer duration of teaching time has a high incidence of positive relationships with students' academic performance due to the more intense and frequent exposure of students to stimuli (Bernardo, 2020; Cavaliere, 2007).

In this sense, considering the relevance of the full time classes on the performance in WM found, as well as the data from the aforementioned research, which point to the association between time at school and better academic performance, it demands greater consideration of this factor in subsequent studies and in public policies. According to Santiago and Santiago (2016), the Full-Time Education Program is a project that aims to achieve the success of education in Brazil. However, there is still a need for significant advances in terms of improving education, such as better school infrastructure and the professional qualification of the teaching staff. Thus, expanding the workload is not enough, it is necessary to consider the need to expand the offer of learning opportunities in a truly integrative and quality education (Bernardo, 2020).

Therefore, our results indicate that the low executive performances are relevant in determining the low performance in mathematics in all areas evaluated in this study, as well as the sociodemographic factors education of parents and full time school, which when influencing executive performance reflect on the efficiency of students in solving mathematical tasks that involve ordinality, the interaction of basic operations, the representation of numerical magnitude and the notion of numerical fact. Finally, it is important to note that this study had limitations specifically related to the sample size of full-time students, suggesting that further exploratory studies explore especially the relationship between executive performance and length of stay in school.

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