Mathematical competence in preschool students and its relationship with intelligence, age and cognitive functions of attention, information processing speed and reaction inhibition

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Abstract: *The purpose of this study is to examine the relationship between flow intelligence (Gf), age and cognitive abilities of processing speed (Comp) of attention (Incomp) and reaction inhibition (Flef) in relation to the level of Mathematical proficiency (MP) of preschool students. Sixty-four kindergarten students participated in the research. Based on the results, it was shown that mathematical competence (MP) shows a strong positive correlation with the variables "age" (age) "flow intelligence" (Gf). These variables were found to be able to predict the level of mathematical competence. The variables "information processing speed" (Comp), "attention" (Incomp) and "reaction inhibition" (Flef) do not seem to be significantly related nor can they predict the level of mathematical competence. These findings can be used both by teachers (e.g. implementation of early intervention programs) and by those responsible for planning and formulating educational policy.*

Keywords: Mathematical competence, flowing intelligence, age, attention, processing speed, reaction inhibition.

INTRODUCTION

There are two approaches to mathematical performance. One approach considers that number recognition and estimation, comparison skills, comprehension, and measurement ability are the determinants of predictive mathematical performance (Geary, Hamson & Hoard 2000; Toll & Van Luit, 2013). These skills represent knowledge and experience gained through contact with the environment (social, cultural, educational) and constitute what is called crystallized intelligence (Gc) (Horn & Cattell, 1967) and require complex cognitive functions.

The second approach estimates that a number of cognitive functions, such as working memory, processing speed, attention, response inhibition (Fias, Menon & Szucs, 2013; Namkung & Fuchs, 2016) have shown a direct relationship to the development of mathematical skills in a wide range of ages (Bull, Espy & Weibe, 2008). However, mathematical performance and its relationship to skills and cognitive functions have not been substantially examined in many critical early areas of mathematics, while most studies usually focus on only one mathematical area.

LITERACY REVIEW

Mathematical performance research provides important information for understanding mathematical difficulties and the factors that contribute to it. Intelligence is an important factor and is associated with a number of cognitive skills, such as processing speed (Fry & Hale, 2000). Some researchers estimate that the effect of processing speed on intelligence is indirect and not direct (Fry & Hale, 1996) while others consider that it affects the performance of intelligence tests directly and indirectly (Kail, 2000). Some researchers (Demetriou et al., 2013) estimate that the power of the relationship between processing speed and intelligence varies with age. Others (Fry & Hale, 2000) argue that there is no systematic change with age in the size of the correlation between processing speed and flowing intelligence.

An attempt has been made to determine the relationship between intelligence and attention. Heitz, Unsworth and Engle (2005) point out that attention is one of the determinants of flowing intelligence. Research results support the correlation between attention and intelligence (Burns, Nettelbeck & McPherson, 2009). But there is very little evidence of this relationship in the child population. Völke & Roebers (2016) report that while working memory and flowing intelligence are significantly related, continuous attention is not directly related to flowing intelligence and working memory in childhood.

Inhibition of reaction as a factor is of great interest because it relates to academic performance (Gottfredson, 1997a, b, 1998). An important issue is the development of inhibition mechanisms and their relationship to the development of intelligence. Studies of school-age children with attention deficit hyperactivity disorder (ADHD) - who have an inability to react due to the disorder - and of normal developmental students have not provided sufficient data linking intelligence to reaction inhibition (Bitsakou et al., 2008; Oosterlaan & Sergeant, 1996; Rubia et al., 1998). But other researchers believe that the two abilities are closely related (Dempster, 1991). In general, there is a correlation between reaction inhibition and flow intelligence but this correlation seems to be small (Michel & Anderson, 2009). Other results show that there is no correlation (Arán - Filippetti, Krumm & Raimondi, 2010).

Research data show that the relationships between different variables are many and also quite complex. For example, processing speed is an important factor associated with academic achievement in childhood and appears to be strongly correlated with attention function (Colom et al, 2008). However, measuring response time to calculate processing speed used in attention studies (de Kieviet et al., 2012) may not be a reliable means of evaluation. Special attention should be taken not to confuse slow processing speed with the Slow Cognitive Tempo (SCT) phenomenon which is a complex of symptoms involving inconsistent alertness and orientation and is characterized by slowness, drowsiness and daydreaming (McBurnett, Pfiffner & Frick, 2001).

Attention and response inhibition are very basic processes, and are related to cognitive processing and are often taken and classified as almost identical (Barkley, 1997). Some researchers attempts have been made to study the relationship between these two cognitive processes, but there are many things to be understood yet. The two functions appear to have the same functional and structural aspects and similar evaluation tests. The similarity of these two functions is so close that researchers often assume that they are two sides of the same coin (Mostofsky & Simmonds, 2008).

Regarding mathematical performance, studies have investigated its correlation with basic processes and factors. Thus, the relationship between mathematical performance, age, intelligence, processing speed, attention, and response inhibition was tested. The age factor and its relationship with academic performance have occupied both researchers and those responsible for designing and formulating educational policy. For example in a kindergarten class some children may be five years old (60 months) while their classmates in the same class may be much older (70 months). Potential differences in performance may be due to the age difference. Studies (Yesil, Dagli & Jones, 2012; Crawford, Dearden & Greaves, 2014) have shown that older children showed better math skills than their younger classmates.

Intelligence is one of the most studied predictors of mathematical performance. The data show that individual differences in mathematical performance are related to intelligence. Characteristically, Cattell (1987) states: "This year's level of competence is a function of the level of current intelligence and last year's interest in schoolwork." The strength of the relationship between intelligence and mathematical performance varies depending on the class, the application of innovations, and the degree of difficulty and complexity of the field of mathematics (Fuchs et al., 2010).

Processing speed is a central mental ability that pushes changes in knowledge to a higher level. High processing speed seems to be associated with higher academic performance. Findings show that children with poorer mathematical performance are slower at processing information (Bull & Johnston, 1997; Geary et al., 2012). Processing speed seems to be closely related to other cognitive functions. Thus it is extremely difficult to answer questions such as whether individual differences in working memory are due to fundamental differences in the speed of cognitive processing and decision making or whether attention accelerates information processing.

Attention is a basic, though less complex than others, cognitive ability, the role of which in relation to the school context is examined. Research on the predictive validity of attention to academic performance provides mixed results. Colom, Escorial, Shih, and Privado (2007) reported only very low and insignificant correlations ($r < 0.20$) between attention and school performance. But another study (Luo, Thompson & Detterman, 2006) showed that basic cognitive processes such as attention are good predictors of school performance. However, the level of attention is probably affected by other cognitive skills, such as executive functions, while the assessment of attention is difficult. The results of intervention training programs vary depending on the type of population being treated and the age. It seems that such programs are more effective in older children with attention deficits and in younger children (Peng & Miller, 2016).

In recent years there has been an increase in studies that have investigated the role of response inhibition in mathematical performance. The majority of studies investigate the degree of correlation between these two factors. For example, performance in response inhibition tests is related to performance, both in informal assessment procedures (Visu-Petra et al., 2011) and in standardized mathematical tests (St Clair-Thompson & Gathercole 2006). However, other research data (Waber et al., 2006) found weak relationships between response inhibition and mathematical performance and there are studies that could not find evidence for the relationship between response inhibition skills and mathematics. Monette et al. (2011) found that response inhibition predicted future performance in reading but not in mathematics.

PURPOSE OF THE STUDY

The purpose of this study is to examine the relationship between mathematical competence with mental ability, age, attention, processing speed and response inhibition. Specifically, what are the relationships between attention, information processing speed, response inhibition, age and mental abilities and what is their relationship with mathematical competence?

Based on the above theoretical and research data, we were led to formulate the research questions:

- Are the variables, mathematical competence, flowing intelligence, age, attention, processing speed, response inhibition related to each other?
- The variables, flowing intelligence, age, attention, processing speed, response inhibition are related to the individual scales of the Utrecht Mathematical Adequacy Criterion and to what extent in the age group of kindergarten students?
- Can cognitive skills, age and flowing intelligence be predictors of mathematical performance and at what level?

METHODOLOGY

Participants

The study involved 64 kindergarten students (36 boys and 28 girls) with an average age of 5 years and 7 months (SD = 5.60 months, min = 56 months, max = 76 months). All students completed the test activities.

Procedure

All participants were assessed by researchers at their school individually during school hours at the end of the school year. The consent of their parents was sought for the whole procedure. The assessment was done individually by the research team in a quiet room of the school at the end of the school year, in the months of May and June. The students who participated in this study were rewarded for their participation and therefore committed to perform the activities correctly.

Measurements

The tools used to measure the cognitive abilities and flowing intelligence (Gf) of the sample students are described below. The children completed their assessment in two phases. In the first phase, flowing intelligence (Gf) and cognitive skills of attention, processing speed and response inhibition were assessed. In the second phase, the degree of mathematical competence was assessed. Children were allowed short breaks during the assessment to ensure optimal assessment conditions.

Flowing intelligence

Flowing intelligence (Gf) has been found to be highly related to general intelligence and has a prominent place in studies on academic performance. Flowing intelligence (Gf) was assessed using Raven Colored Progressive Matrices (CPM), which requires analytical reasoning for abstract audiovisual material. This test is known to be one of the most important tests for assessing flowing intelligence. Its instructions are simple and its implementation takes little time. Students were asked to choose the correct one for each item on the answer sheet. Silence and individual work were necessary. The maximum score was 36.

Mathematical competence

Early mathematical competence refers to the overall level of knowledge and skills required to effectively introduce a preschool and early school child to formal school mathematics (Van de Rijt, Van Luit & Pennings, 1994). The Utrecht Early Mathematical Competence Criterion was chosen for the assessment of early mathematical competence. This is a single test consisting of eight scales of tests - questions. The scale of the criterion covers both Piaget's skills (comparison, classification, matching and serialization) and counting skills. This criterion is used to assess the level of development of early arithmetic ability. The eight sections of the criterion are: Comparison, classification, matching, serialization, use of numbering words, structured counting, effective counting, general knowledge of numbers.

Attention, processing speed, response inhibition.

The cognitive functions of attention, processing speed and response inhibition were measured by the Eriksen Flanker Task test (Eriksen & Eriksen, 1974). Compatible reaction times in Stroop, Simon and Eriksen's works are used to measure information processing speed, while incompatible reaction times are used to measure processing control. In the above tests the reaction times to the compatible condition are shorter than the reaction times to the incompatible condition. The difference in performance between Compatible and incompatible conditions is called the "Flanker effect" and is considered to measure the inhibition of the reaction. In other words, it measures the ability to inhibit irrelevant competing responses to a non-verbal stimulus (Eriksen & Eriksen, 1974).

RESULTS

Descriptive statistics

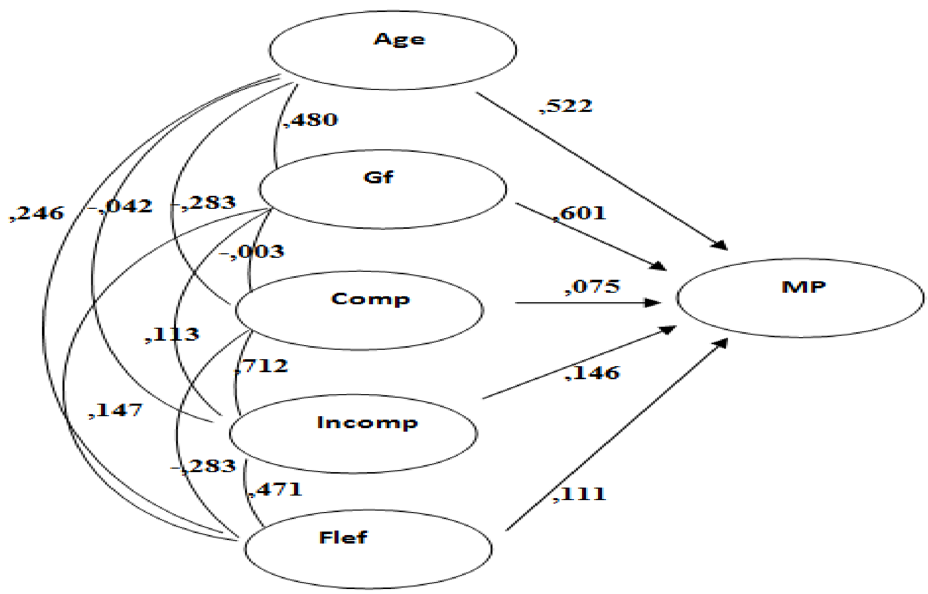
The averages, standard deviations, performance range, lowest and highest performance per assessment category are presented in the table below (Table 1). Based on the data of the statistical table, it is observed that the average mathematical performance (MP) of the sample was 29.71 (Std. D = 7.3), the average age was 66.68 months, the performance in the measuring tool of flowing intelligence (Gf) was 19.21 (Std. D = 4.65). The average performance in measuring the processing speed (Comp) was 1209.3 (Std. D = 174.54), the average performance in attention control (Incomp) was 1220.28 (Std. D = 188.35) and the average performance in the response inhibition test (Flef) was 12.59 (Std. D = 137.74).

	Mean	Standard Deviation (Std.D)	Sample (N)
MP	29,7188	7,39040	64
age	66,6875	5,61425	64
Gf	19,2188	4,65123	64
Comp	1209,3125	174,54584	64
Incomp	1220,2813	188,35297	64
Flef	12,5938	137,74761	64

MP= Maths performance, **Age**, **Gf**= flowing intelligence, **Comp**= processing speed, **Incomp**= attention control, **Flef**= response inhibition

Table 1: Descriptive Statistics

The Pearson correlation coefficient was calculated to examine the correlations between the areas of assessment (Figure 1).



MP= Maths performance**, Age, Gf**= flowing intelligence, **Comp**= processing speed**, Incomp**= attention control, **Flef**= response inhibition

Figure 1: Correlations between variables

The above figure (figure 1) also shows the correlation of variables with mathematical competence (MP). The results show that mathematical competence (MP) has a strong positive correlation with age (r = ,522) and flowing intelligence (Gf) (r = ,601), while the correlation with processing speed (Comp) (r= ,075), attention (Incomp) (r = ,146) and reaction inhibition (Flef) (r = ,111) is weak.

However, in order to be able to answer the second research question concerning the correlation of the individual scales of the Utrecht mathematical criterion (comparison - Com, classification Ci, matching - mat, serialization - seq, use of numbering words - Numw, structured counting - Str , effective counting - Efco, general knowledge of numbers - Knon) are related and to what extent with variables, flow intelligence (Gf), age (age), attention (Incomp), processing speed (Comp), reaction inhibition (Flef). The results are presented in Table 2.

	Age	Gf	Comp	Incomp	Flef
Com	-,154	,096	-,136	-,181	-,072
Ci	,251	,460	,144	,369	,330
Mat	,474	,513	-,083	-,010	,093
seq	,306	,313	,055	,024	-,028
Numw	,350	,578	,065	,187	,170
Strc	,534	,585	,179	,108	-,067
Efco	,482	,385	,086	,216	,195
Knon	,456	,506	,002	,018	,025

Com= comparison, **Ci**= classification, **Mat**= matching, **seq**= Sequencing, **Numw**= use of number words, **Strc**= structured count, **Efco**= effective count, **Knon** = General knowledge of numbers, **MP**= mathematical competence, **age**= age, **Gf**= flowing intelligence, **Comp**= processing speed, **Incomp**= attention, **Flef**= response inhibition

Table 2: Correlations of the variables

Based on these results (Table 2) it seems that all subscales (except the comparison subscale - Com) of the mathematical competence test are moderately to strongly related with the variables age (Gf) and flowing intelligence (Gf) while they are very weakly related or not at all with the variables attention (Incomp), processing speed (Comp) and response inhibition (Flef). An exception is the classification - (Ci) which shows that it is the only one of the subscales of the mathematical competence criterion that shows a moderate correlation with the variables processing speed - (Comp) (r = ,369) and response inhibition - (Flef) (r = ,330).

In order to answer the third research question, that is which of the variables we examine can contribute to the level of mathematical competence, a regression analysis was performed. It was chosen to enter all the variables at the same time to determine which of the defined variables contribute to the mathematical competence and how much variation they explain. During the adjustment test (table 3 – model summary) it seems that the model explains 47.6% of the total variability (R Square = ,476) while the Adjusted R Square index is ,431. The comparison of the two indicators (R Square and Adjusted R Square) shows that the findings can be generalized to the population.

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	,690[a]	,476	,431	5,57448

a. Predictors: (Constant), Flef, Gf, Comp, Age, Incomp

Table 3: Model Summary

Regarding the significance of the model (Table 4) we observe that the F-test shows a significance of sig <0.000 so the model is very important for explaining variability and contributes significantly to the prediction of mathematical competence.

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	1638,599	5	327,720	10,546	,000[b]
	Residual	1802,339	58	31,075		
	Total	3440,938	63			

a. Dependent Variable: MP

b. Predictors: (Constant), Flef, Gf, Comp, Age, Incomp

Table 4: Significance of the model (ANOVA)

The results on the degree of contribution of the variables to mathematical competence are presented in table 5. Regarding the parameters of the model as shown (table 5) the coefficients of the variables are positive while only the variable attention (Incomp) has a negative value - ,161. The Unstandardized Coefficient is ,370 for the variable "age", and ,792 for the "flowing intelligence" (Gf). Therefore for each increase of these variables by one unit the effect on the increase of mathematical competence is respectively, 370 from the contribution of the increase of age (Sig = ,025) and ,792 from the contribution of the flow of intelligence, (Sig. = ,025).

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Correlations		
	B	Std. Error	Beta			Zero-order	Partial	Part
(Constant)	-16,159	11,847		-1,364	,178			
age	,370	,161	,281	2,306	,025	,522	,290	,219
Gf	,792	,187	,498	4,236	,000	,601	,486	,403
Comp	,166	,105	3,919	1,586	,118	,075	,204	,151
Incomp	-,161	,106	-4,109	-1,523	,133	,146	-,196	-,145
Flef	,162	,106	3,014	1,525	,133	,111	,196	,145

a. Dependent Variable: MP

Table 5: Coefficients

DISCUSSION

The aim of this study was to examine the variables related to the level of mathematical competence of students at the end of kindergarten, before attending primary school. The possibility of predicting the variables "flowing intelligence" (Gf), "age", "attention" (Incomp), "information processing speed" (Comp), and "reaction inhibition" (Flef) for mathematical competence (MP) was also examined. In addition to the correlation of the level of mathematical competence (according to the mathematical competence criterion of Utrecht) there was a detailed correlation of the individual scales of the criterion of mathematical competence of Utrecht with the factors "flowing intelligence" (Gf), "age", and the cognitive functions "attention" (Incomp), "Information Processing Speed" (Comp) and "Reaction Inhibition" (Flef). This was done to investigate the possible correlations between these variables and the individual scales of the Utrecht mathematical competence criterion. In other words, a more detailed investigation was carried out in order to show correlations that may not be seen from the overall degree (score) of performance of the Utrecht mathematical competence criterion. For example, the degree of final performance in the mathematical competence criterion, which is the result of overall performance on all eight scales, may not be related to the variable "attention". However, we cannot rule out the possibility that some of the eight scales of the mathematical competence criterion, which constitute the overall degree of performance of the criterion, are related to the variable "attention".

Based on the results (Figure 1) the first question of the research is answered (if and to what extent the variables are related to each other). We observe that the variable mathematical competence (MP) is significantly related to the variables "flowing intelligence" (Gf) (r = ,601) and "age" (r = ,522). These results are in line with research findings that show a strong correlation between mathematical performance (MP) and "flowing intelligence" (Gf) (McGrew & Wendling, 2010). The results of the present study also confirm the results of those studies that show a strong correlation between mathematical performance and age. It has been observed that older children, score higher in mathematics (Crawford, Dearden, & Greaves, 2014; Yesil Dagli & Jones, 2012). The "age" factor is positively correlated to a moderate degree (r = ,480) with the "flowing intelligence". The research findings are in line with the results of research showing that flowing intelligence increases into early adulthood (Ackerman, 1996; McArdle et al., 2000).

Variable "processing speed" (Comp) is significantly related to variable “attention” (Incomp) (r =, 712). Research findings show that information processing speed and attention are strongly correlated. In a research study (colom et al, 2008) it was shown that the two cognitive functions are positively related to each other to a large extent. In fact, “processing speed” was found to explain a large percentage of attention span (McAuley & White, 2011). Also, processing speed tests are able to predict the level of attention, because processing speed requires activation and attention resources (Diamond, 2002).

Variable “reaction inhibition” (Flef) is positively related to “attention” (Incomp) (r = ,471). The results of the present study are confirmed by the results of research that show that the two functions are so closely related that researchers often consider that they are essentially two sides of the same coin (Mostofsky & Simmonds, 2008).

Particularly important is the fact that in the present study not only the skills and cognitive functions in relation to mathematical competence were examined but also their relationship with the individual scales of the Utrecht mathematical competency criterion was examined to identify any correlations (second research question).

We do not know of any other research that has examined a correlation of this kind in this age group. The results (Table 2) showed that all sub-scales of Utrecht's mathematical proficiency testing tool (except the comparison - Com) are moderately to strongly related to the variables "age" and "flowing intelligence" (Gf) and very weakly or not at all with the variables "attention" (Incomp), "processing speed" (Comp) and "reaction inhibition" (Flef). Of the eight scales of the mathematical competence criterion, the "classification" scale (Ci) seems to be the only one that shows a moderate correlation with the variables "processing speed" (Comp) (r = ,369) and "reaction inhibition" (Flef) (r = ,330). The results show that the individual scales of mathematical competence have to a large extent the same tendency of correlation as the overall degree (score) of performance of the Utrecht mathematical competency criterion with the variables "intelligence", "age", "processing speed", "attention", "reaction inhibition".

Predicting future performance when a child attends kindergarten is very important. Based on research data, mathematical competence in kindergarten can predict the level of mathematical performance while attending primary school (Jordan, Kaplan, Ramineni & Locuniak, 2009). For this reason, it is extremely useful to know the factors that contribute and can predict the level of mathematical competence (third research question). Based on the results of this research, "flowing intelligence" (Gf) and "age" (age) are strongly related to the level of "mathematical competence" (MP) and can predict it. The results of the present study are in line with the findings of other research (Ferrer & McArdle, 2004; Manginas, Nikolantonakis & Papageorgiou, 2017) which show that some cognitive abilities such as working memory (wm) and flow intelligence (Gf) in addition to their correlation with mathematical performance can also contribute to being the main predictors of academic and mathematical performance. Some findings even show that flowing intelligence is a very powerful predictor of mathematical performance and even stronger than that of age (Green, Bunge, Chiongbian, Barrow & Ferrer, 2017). It seems that the basic reasoning skills, which are characteristic of flowing intelligence, can predict the acquisition of mathematical skills.

In the present study, the relationship between "age" and "mathematical competence" (older children performed better than younger ones), shows that "age" is another important predictor of "mathematical competence" (MP), a finding that is confirmed by previous studies (Jordan et al., 2006). The better performance and faster development (between first and third grade of elementary school) of older children's math ability can be predicted by the difference in math ability in kindergarten. In fact, the differences in cognitive development between younger and older children seem to be there before they start school education (Musch & Grondin, 2001). This is likely because older children (a) are simply older and on average more mature (Bedard & Dhuey, 2008; Stipek, 2002), and (b) have received more experience and support (Gold et al. , 2012). Therefore, younger children in kindergarten may have a lower level of maturity in a number of factors and cognitive abilities that in turn affect mathematical performance. After entering the formal education system, these differences still exist or even increase, because the curricula in each class are aimed at high-achieving students and do not favor younger students (Elder & Lubotsky, 2009). However, the attitude of teachers towards students is also different, as teachers have more expectations from the older students in the class, they motivate the older students more, which has a positive learning effect on them, showing a steeper learning curve in them (Stipek, 2002).

The findings of the present study demonstrate the importance of mathematical competence in kindergarten in determining the developmental course of students in primary school mathematics. A seemingly small problem in preschool can cause big problems as the child grows (Karmiloff-Smith, 1998). If children finish kindergarten with a low level of certain abilities and skills, they will go to the next level of education from a disadvantaged position and may never reach the level of children who start primary school with a good level of skills and abilities. Therefore, defining the impact and role of skills and cognitive functions can help in the design and implementation of successful early educational intervention programs that will aim to improve specific skills and functions that positively affect mathematical performance. In this context, the results of the present research can be very useful, especially if we take into account the fact that cognitive skills activities such as reasoning and mental work activities are predictors of academic performance (Deary, Strand, Smith, & Fernandes, 2007; Detterman, 2014a,b; Rindermann & Neubauer, 2004; Schmidt, 2017). It is estimated that the skills practiced through cognitive training programs affect a wide range of areas (Taatgen, 2016). This is especially important for pre-school education because factors such as flowing intelligence and cognitive functions are quite flexible at an early age and can be improved through specialized intervention programs. Flowing intelligence for example has been shown to improve through appropriate educational activities, such as through non-verbal reasoning games (Au et al., 2015). Based on the results of the present research, the factor "flowing intelligence" is particularly decisive for the level of mathematical competence. Therefore, preschool teachers need to pay special attention to this factor and plan and implement activities and programs that will enhance basic reasoning skills. This will have a positive impact on the level of operation of the flowing intelligence. For example, the inclusion of young students in the kindergarten program and the involvement of board games have a positive effect on the level of abstract and comparative ability that are key elements of mental function. Starting at this age with the "classic" bricks and children's puzzles, the child can develop basic reasoning skills. Games of this type reinforce logic, enhance correlation, enhance the identification of essential elements for problem-solving, and have a positive effect on the level of mental ability. Also, engaging in appropriate digital games has been found to have a positive effect on the level of mental function (Manginas & Nikolantonakis, 2017, 2018). Therefore digital games could be included in the program of activities of the kindergarten students. So in addition to pleasure, enjoyment and satisfaction can be a means of improving the level of mental function. But also engaging with music can have a positive effect on the level of mental function. Especially when the young child learns a musical instrument, his mental skills are strengthened. Research data show a strong correlation between musical audiation and mathematical performance (Manginas, Nikolantonakis, Gounaropoulou, 2018). Mathematics is an activity of organizing and solving problems. However, learning music requires (like mathematics), the organization of information, the creation of structures, and the solution of problems (Pogonowski, 1987). Learning music pushes the student to try to discover different patterns and create structures (Gopnik et al., 2004). But also learning foreign languages seems to be able to contribute positively to the level of mental function (Pimsleur, 1968). Therefore, targeted actions, such as those mentioned, contribute to the increase of the level of mental function. According to the findings of the present study, this will have a positive impact on mathematical performance.

Comparing the relative effects of age differences between students provides important information to teachers. Different levels of children's skills are related to age, which is a factor that is often cited by kindergarten teachers as an obstacle to the implementation of effective teaching (Rimm-Kaufman et al., 2000; Vecchiotti, 2001). The age of the child entering school is also a factor in creating beliefs in teachers about the performance of students (young age is to blame for poor performance of the student) which can have consequences for the child's experiences at school. But parents also systematically identify age as one of the most important dimensions of their view of school readiness (Brent et al., 1996; West et al., 1993). The view of some (Uphoff & Gilmore, 1986) is correct that older children will be more prepared than younger children, so that the increasingly demanding kindergarten curriculum can be fully utilized. But there is also the view that the duration of study in an educational environment is more important than biological maturation and children should be given the opportunity to benefit from school (Stipek, 2002). In addition, school attendance also functions as a compensation mechanism, which is particularly important for children from less privileged family environments, where the level of experience and knowledge is relatively low (Vecchiotti, 2001). This view also has a strong basis and influences educational decisions. Teachers when they find that there are age differences in the classroom between students and because they know the importance of the factor "age" in mathematical performance and general academic performance must make the necessary adaptations and adjustments. Especially in cases where the age differences are not very large and there are not very large differences in performance, the learning unit should be organized on the basis of objectives that will be a graded difficulty so that students can respond according to their level. The teacher should have identified what the student can learn and how they will learn it. Extensive use of the worksheet card could be very effective. Each worksheet card should include a specific learning objective as well as instructions for the process to be followed. The student should also be aware of the material at his disposal, to be able to easily access it as well as a variety of learning tools and resources. Especially in the subject of mathematics where the degree of abstraction is particularly high, the access and use of the material are of great importance. In cases where there are large age differences in a classroom and if these differences affect mathematical performance then the application of a different model of classroom organization should be considered. The class should be divided into groups and subgroups (each color differently). The purpose of segregation is to provide individualized teaching to students more effectively, to improve learning motivation, and to be able to function more effectively. Such an organization of the classroom enables the children to work in small heterogeneous groups, to help each other, and to consider each other's points of view. Heterogeneous groups create models of differentiation, which give students the opportunity to achieve different goals through alternative learning models.

The program could also include several regular breaks in which the students of the working groups can express and share their experiences, concerns and thoughts, especially the younger ones with the older students. To discuss and find solutions to the issues that arises.

Improving math skills should be a priority in kindergarten and the first grades of primary school. Until recently, however, early interventions related to mathematics have attracted much less interest than early intervention programs in reading (Fuchs, 2005; Gersten et al., 2005). However, the mathematical difficulties in kindergarten and primary school can be predicted to a large extent (Dowker, 2005), an event that is of particular importance.

CONCLUSIONS – PROPOSALLS

The findings of the present study add to the growing body of research findings. The level of flowing intelligence and the age of the child are strongly related and seem to play an important role in the degree of mathematical competence. These factors can also predict the future mathematical level and therefore must be taken into account for the implementation of the necessary interventions at both educational and administrative level. We also believe that they can contribute to the planning and adoption of educational and policy interventions, measures and decisions in the direction of maximizing the educational result in the field of mathematical knowledge. At the educational level, the design and implementation of intervention programs must be approached with great care. Early learning is not just a "vaccination" that necessarily produces subsequent benefits. There are many factors to consider. Theories about the processes of creating and developing skills, the impact of skills in areas of mathematical knowledge, and the effective use of findings require constant research, continuous monitoring, data control, and possibly interventions and revisions. The results of the present study can be used in the development and implementation of programs that will improve the level of mental function in the age group of kindergarten students. Thus students will be able to have a higher level of mathematical competence which will result in better access to mathematical knowledge even in highly demanding areas such as the field of mental calculations. The implementation of intervention programs will result in the enhancement of interest and active participation along with an increased degree of enjoyment and satisfaction. Learning objectives are more easily achieved and the student can learn in a fun and engaging way.

At the decision-making level, educational policymakers such as the age of onset of kindergarten should rely on research data to maximize academic achievement and mathematical performance. Deciding on a child's enrollment age is certainly not an easy task. However, the fact that age plays a very important role in the mathematical performance and that the curriculum of the kindergarten is becoming more and more demanding must be taken seriously. Therefore, the educational community and educational policy-making institutions must have access to continuous and reliable information, the possibility of checking and an increased degree of flexibility in the application of new research data, the review of previous decisions and the continuous monitoring of measures, interventions and applicable regulations.

We believe that the present work provides evidence that the investigation of factors that affect the learning of mathematics in preschool children such as basic skills and cognitive functions is possible and necessary. With such an approach, a new dimension is given to the methodology of intervention in the field of mathematics. However, the role of factors that affect mathematical performance in other age groups besides kindergarten, such as first graders in elementary school, should be explored.

It should also be investigated which other factors affect and to what extent mathematical performance in different categories of students such as students with intellectual disabilities, students with learning disabilities or autism spectrum disorder (ASD), etc. It is also particularly important to investigate more the factors that can predict mathematical performance to enable early intervention programs.

It would be interesting to investigate the factors that influence or can predict performance in other academic areas (e.g. language courses, science courses, etc.) during students' pre-school education. In fact, the comparison of the role of these factors with each other would be of particular interest, allowing the design and implementation of more effective early intervention programs.

With the implementation of early intervention programs, the school innovates and effectively tackles stability and immobility, which often takes the form of stagnation with the main feature being the obsession with tradition. It is necessary for teachers to be informed about the new data from the research findings and to be encouraged to implement modern curricula and teaching methods. In this context, the area of pre-school education and basic education with options, modern and scientifically substantiated, must also move.

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