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Research on Executive Function Characteristics of Preschool Children in China

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Abstract

Executive function (EF) refers to a range of mental abilities that allow people to control their actions, thoughts, and feelings. Children's EF is crucial to their early academic success, especially in mathematics, when they are in preschool. Research on the connections between EF and mathematics learning in Chinese preschoolers is few, despite the centrality of EF to academic success. The goal of this study is to get a thorough understanding of the variables that affect Chinese preschoolers' executive function (EF). This study employs a quantitative methodology. The data is summarized by looking at the total and also the percentage using the frequency analysis. Descriptive analysis, Pearson correlation analysis, and multiple regression analysis are further methods used to examine the components. Inhibition and flexibility were shown to have a significant link with mathematics learning. Still, working memory was found to have no significant relationship with problems in mathematics learning. The results suggest that interventions that specifically target the development of inhibition and flexibility might be helpful for children who struggle with mathematics learning.

Keywords: Executive Function, Mathematics Learning, Working Memory, Inhibition Flexibility.

Introduction

The effectiveness of mathematics teaching and the reform of mathematics education are impacted by the significance that students put on various components of their mathematical learning experiences (Hussein, 2021). Matthew and Omobola (2020), revealed that students' mathematical values predicted effort more accurately than success expectations, and that value and effort together accounted for more than a quarter of the range in math scores. Whelan et al (2020), revealed that students' mathematical values predicted effort more accurately than success expectations, and that value and effort together accounted for more than a quarter of the range in math scores. In order to manage their learning activities, students' opinions of "what is fundamental in mathematics learning" were very important. Mathematics instruction is a culturally interactive activity in which the values of the ’s guide their decisions and judgments, which in turn affect the students. Zhang, Mankad and Ariyawardana (2020), claimed that linkages were made, students' cultural identities were validated, students were more interested, and mathematics learning was ultimately better when values were recognized in the mathematics classroom. It is crucial to take students' beliefs into account while promoting change since the reform of mathematics education is a type of cultural practice. This knowledge has important practical ramifications for China's current reform of its mathematics curriculum, which intends to develop students' fundamental skills including reasoning modeling, creativity, and spatial awareness (Eshragh et al., 2020). Other countries have revised their curricula using competencies (Gates-Rector & Blanton, 2019). China is highly unique from most other countries and has a long history and ongoing civilization. The world's civilizations, particularly those of the West (Englund & Graham, 2019). In extensive worldwide examinations of mathematical accomplishment, it has been claimed that children in East-Asia, including China, did better than those in the West (Zagzebski, 2017). The way that mathematics is taught in China has garnered a lot of interest from both the educational and broader social groups.

Problem Statement

Executive function (EF) refers to a range of mental abilities that allow people to control their actions, thoughts, and feelings. Children's EF is crucial to their early academic success, especially in mathematics, when they are in preschool. Research on the connections between EF and mathematics learning in Chinese preschoolers is few, despite the centrality of EF to academic success. Therefore, the goal of this research is to examine the connections between overall EF, as well as its subcomponents working memory, inhibition, and flexibility, and mathematical development in Chinese preschoolers. (Friso-Van Den Bos et al., 2013) Furthermore, this research intends to assess the distinct roles of each EF subcomponent in predicting mathematics learning, while accounting for the impact of demographic variables.

The cognitive viewpoint is used in this study to understand children's learning difficulties (Bordeleau et al., 2020). Few research in China have looked at the cognitive traits of pupils who struggle with learning. Even while Chinese students often do well on the Program for International Student Assessment (PISA), notably in mathematics, the proportion of Chinese children with learning difficulties is still rather significant (Karman, 2020). I It has been suggested that EF is an umbrella term covering mental operations including planning, sustaining, shifting, and inhibition as a nebulous cognitive domain (Davidson, 2020). Core EFs are needed for setting goals, adjusting plans, resisting temptations, and breaking previously established rules. They include inhibition, working memory, and cognitive flexibility (Zhang et al., 2020).in addition, there is lack of research on the relationship between executive function and mathematics learning among China's pre-school children. Therefore, the link between executive function (EF) and mathematics learning among China's pre-school children has been the subject of discussion on a number of important fronts. Mathematical difficulties may cause a significant impairment in skills connected to calculation.

Research Objectives

This research aims to:

i. Identify the level of EF among preschoolers in China.
ii. Determine the relationship on the working memory and mathematics learning among the preschoolers in China.
iii. Determine the relationship on the inhibition and mathematics learning among the preschoolers in China.
iv. Determine the relationship on the flexibility and mathematics learning among the preschoolers in China.

Preschool Mathematics Curriculum

The mathematical abilities of China children were superior in practically every measurable way (Toll et al., 2011), A higher proportion of China parents used authoritarian methods (Star & Pollack, 2015). Researchers have found that China parents place a high value on education, and that they view their children's achievement primarily in terms of academic achievement. These researchers include Liberna et al. (2021). Yamin-Ali (2021) thought about the role that application plays in mathematics teaching and learning and noted that this presents very specific challenges because the capacity to stimulate working memory cannot cope with the mastery of mathematical procedures, understand the meaning of the procedures, and see how to apply? There is little doubt that the constraints of working memory are a major factor in mathematical difficulty

Preschool Mathematics Learning in China

The quality of China's preschools, especially those run by private companies, has risen steadily in recent years. A greater number of preschools are run by private organizations than by the government. In addition to the many rules and regulations the government has enacted for kindergartens, it has also mandated extensive training for preschool instructors (Q. Wang & Wang, 2020). This is because the government places a premium on the quality of preschool educators. The findings revealed that early mathematics instruction in Chinese preschools places a greater emphasis on the memorization of essential mathematical ideas and abilities and less emphasis on their application in real-world and non-routine problem-solving contexts. Teachers take a central part in the communal teaching activities specified in the reference books, and this was determined to be the primary form of instruction for early mathematics in Chinese preschools. However, few activities were identified to include a problem-solving component, and the teacher's role is not defined in depth.

Challenges Faced by Preschoolers in Learning Mathematics

Lack of Soft Skills Training in the China Education System

There is a deficiency in China's education system when it comes to teaching "soft skills," or interpersonal in China. Counting, number sense and imperceptibility (Mathis et al., 2019), number patterns using calculators (Groves & Stacey, 1998), analogical reasoning (Attard & Holmes, 2020), and problem solving have all been modeled in research on elementary school students' mathematical concepts and problem-solving processes (Lee et al., 2020) The development of young children's pattern skills in early childhood care settings has, however, received less attention in research. Describe understanding of patterns in the kindergarten context of developing children was the topic of a research (Brendefur et al., 2013).

Mathematics Learning Difficulties

In previous research, Knight and Wood(2005) noted that preschool children often find math difficult. The quality of education in public schools in Pakistan is very poor, mainly reflected in the limited teaching ability and cognitive knowledge of teachers, which limits students' mastery of mathematics ((Kisielnicki & Markowski, 2021). Deep learning helps learners to efficiently solve problems since it "gives its owner a certain cognitive . autonomy" (Smithies et al., 1985), But most students can't think for themselves, In this research, the terms "math anxiety" and "math phobia" allude to irrational concerns and phobias about arithmetic.

Literature Review

Research shows that young children who enter kindergarten with strong executive functioning have an advantage in numeracy that persists throughout elementary school and even after college, and that there is a small but statistically significant link between EF and academic functioning in preschool students, and that the link between EF and reading ability is well established((Zurcher et al., 2020, Armstrong 2020, (Viriyasitavat et al., 2019, Qalati et al., 2021).This is despite the fact that most of the current research on EF and academic achievement is about mathematics. In particular with regard to working memory (Rabinow, 2020), working memory problems are particularly relevant to learning problems and specific learning disabilities because EF plays a crucial role in learning and there is a significant correlation between EF and academic success (Green et al., 2021).Working memory is the term used to describe the constrained active information processing resources required to carry out cognitive processes like understanding, analyzing, and learning. Working memory research was reviewed by Baddeley in 1999 and 2000. In general, new information is processed in working memory and given a meaning before being stored in longer-term memory, which is more durable. Working memory has a limited capacity and is susceptible to information loss inside it owing to the displacement of additional incoming information.

In reality, inhibition problems are a common occurrence in everyday life. It is vital to explain the inhibition point of view that this study will use before going through each of the two examples individually. In talks about learning, forgetting has long been neglected. According to Cooper and Schindler (2006), researchers con-tend that forgetting is mostly the product of the executive control mechanisms that are activated to deal with the response competition that develops during memory retrieval. Inhibition promotes learning at the cost of memory retention of other information, as this study witnessed in RIF once again. Nevertheless, research into the intricate relationship between learning and forgetting is ongoing. For instance, Kaufman and Knoll (1995), offered preliminary proof that implicit memory tests of tar-get trajectories are not affected by explicit memory deficiencies. Future research will provide lighter on how long and how much forgetfulness occurs as a result of deliberate suppression.

In this study, flexibility means that students can choose the appropriate time and learning pathway, including e-learning, open learning, distance learning or blended learning often associated with flexible learning (A. Kumar & Paul, 2018). My research also refers to his theoretical investigation of flexible learning (Oleksen-ko et al., 2018), creating a model that includes three aspects: flexibility in time management, flexibility in teacher relations, and flexibility in disciplines (Cooper & Schindler, 2006).H3: Flexibility is significant related to mathematics learning difficulties.

Methodology

In this study, questionnaire is used to collect the data from the respondents. The use of "suitable" respondents for the researcher constitutes convenience sampling. 384 samples are required for this study. The questionnaire consists of two parts. First part is about demographic, second part is the measurement items for mathematic learning, working memory, inhibition and flexibility. This study employs a quantitative methodology and employs SPSS 25.0 (Statistical Package for the Social Sciences) to conduct statistical analysis. The researcher decides to conduct a reliability study to determine the validity of the collected data. The data is then summarized by looking at the total and also the percentage using the frequency analysis. Descriptive analysis, Pearson correlation analysis, and multiple regression analysis are further methods used to examine the components.

Findings

Table 1

Descriptive statistics of the Variables

Descriptive Statistics			
	mean	Std.deviation	N
Mathematics learning (DV)	3.6349	.80865	384
Working Memory (IV1)	3.7661	.76435	384
Inhibition (IV2	3.8465	.91614	384
Flexibility (IV3	3.9359	.77187	384

From table 1, when rating each unique characteristic, we employed a five-point Likert scale. The scale ranges from 1 (Strongly Disagree) to 5 (Strongly Agree) when it comes to concerns around learning mathematics, working memory, inhibition, and flexibility (Strongly Agree). The overall average of all elements is more than 3, with flexibility having the most excellent mean score of all factors and working memory having the lowest overall mean score of 3.7661.

Table 2

Correlations

correlations					
		DV	IV1	IV2	IV3
Pearson correlation	DV	1.000	.464	.699	.667
	IV1	.464	1.000	.662	.557
	IV2	.699	.662	1.000	.903
	IV3	.667	.557	.903	1.000
Sig. (1-tailed)	DV	.	.000	.000	.000
	IV1	.000	.	.000	.000
	IV2	.000	.000	.	.000
	IV3	.000	.000	.000	.
N	DV	384	384	384	384
	IV1	384	384	384	384
	IV2	384	384	384	384
	IV3	384	384	384	384

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B		Correlations			Collinearity Statistics	
		B	Std. Error	Beta			Lower Bound	Upper Bound	Zero-order	Partial	Part	Tolerance	VIF
1	(Constant)	1.025	.183		5.590	.000	.664	1.385					
	IV1	.019	.052	.018	.359	.720	-.083	.121	.464	.018	.013	.552	1.810
	IV2	.450	.084	.510	5.362	.000	.285	.615	.699	.265	.195	.147	6.797
	IV3	.206	.090	.196	2.290	.023	.029	.382	.667	.117	.083	.181	5.535

a. Dependent Variable: DV

There is a very significant relationship (r=0.464, p<0.001) between students' working memory and their ability to learn mathematics. Inhibition is positively related to mathematical knowledge (r=699, p<0.001). Learning mathematics is correlated with flexibility (r=0.667, p<0.001). People with higher correlation values tend to be good at arithmetic. Those that score lower on the correlation scale tend to be less successful in school. One's intrinsic motivation to study mathematics is related to working memory, inhibition and flexibility.

Table 3
Model Summary

Model Summary[b]										
					Change Statistics					Durbin-Watson
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	R Square Change	F Change	df1	df2	Sig. F Change	
1	.704[a]	.495	.491	.57685	.495	124.220	3	380	.000	1.488

a. Predictors: (Constant), IV3, IV1, IV2

b. Dependent Variable: DV

The results of the ANOVA are shown in Table below; the F value of 124.220 demonstrates that there is a statistically significant relationship between the two variables at the 0.000 level. According to this discovery, the four independent variables significantly explain 49.5 percent of the variance (R-squared) in consumers' inclinations to mathematics learning among the young children in China. In this study, only 49.5 percent of intention in mathematics learning could predict working memory, inhibition and flexibility.

Table 4
ANOVA

ANOVA[a]						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	124.005	3	41.335	124.220	.000[b]
	Residual	126.448	380	.333		
	Total	250.452	383			

In Table below, the coefficients for each model are shown, a summary of the hypothesis is given, along with a demonstration of which factors have an effect on mathematics learning among the young children in China. The findings indicate that inhibition and flexibility are all significant ($p<0.05$), working environment is not influenced mathematics learning at this time. This finding contrasts with the findings on inhibition and flexibility.

Table 5 Coefficients
From the Coefficients Table 5, the values for independent variable, "inhibition" (β = 0. 450, t = 5.362, p = 0.000 < 0.05), indicating that there is a significant relationship between inhibition and mathematics learning. As the significant value of this variable is smaller than 0.05, H2 is supported. The beta value shows that there is a positive relationship between perceived benefits and travel intentions. Besides that, "flexibility" (β = 0. 206, t = 2.290, p = 0. 023 < 0.05), indicating that there is a significant relationship between flexibility and mathematics learning. As the significant value of this variable is smaller than 0.05, H3 is supported. However, the values for independent variable, "working memory" (β = 0. 0198, t = 0.359, p = 0. 720 > 0.05), indicating that there is an insignificant relationship between working memory and mathematics learning. As the significant value of this variable is greater than 0.05, H1 is not supported.

The tabulated findings of the study's hypothesis testing may be seen below. These research results were reported in a subsequent chapter, which also included an in-depth analysis of those results and demonstrated how they supported the earlier conclusions. The findings of this inquiry provide evidence that supports hypotheses 2 and 3. However, those supporting hypothesis 1 were found to be rejected.

Table 6
Summary of Hypothesis Analysis

Hypothesis	Description	Result
Hypothesis 1	Working memory is significantly related to mathematics learning difficulties.	Not Supported
Hypothesis 2	Inhibition is significantly related to mathematics learning difficulties.	Supported
Hypothesis 3	Flexibility is significantly related to mathematics learning difficulties.	Supported

Discussion

Working Memory is Significantly Related to Mathematics Learning Difficulties

According to the findings of this research, problems with one's working memory are directly related to difficulties in one's ability to learn mathematics (H1). The findings of this research do not support the hypothesis that H1 is correct since no statistically significant association was discovered between the degree to which a learner struggles with mathematics and their ability for working memory. There is a possibility that the lack of significance in the association can be attributed to several different factors, including the age range of the participants, the kind of activities used to evaluate working memory, and the measurements used to evaluate difficulties in mathematical learning.The fact that there was no link between age and difficulty in mathematics learning and working memory in this research may have something to do with the fact that the sample of participants came from a wide range of ages. According to the findings of earlier research, the effect of a person's working memory on their ability to solve mathematical problems may change as they become older (Memisevic & Biscevic, 2018; Shaul & Schwartz, 2014). The findings of this study indicate that there is no evidence to support the hypothesis that preschool Chinese children's working memory capacity is connected with the mathematics learning difficulties they experience (Ha, 2022). However, this does not detract from the significance of working memory in relation to other aspects of cognition or later life. Future research might elaborate on these findings that studies the link between working memory and mathematics learning in preteens and adolescents.

Inhibition is Significantly Related to Mathematics Learning Difficulties

Inhibition plays a crucial part in the genesis of mathematics learning problems. This conclusion agrees with the prior study's findings, which show that inhibition is an es-sential cognitive function that significantly impacts academic attainment among pre-schoolers in China. Children with a more vital ability for inhibition can bet-ter filter out unimportant stimuli and focus on their mathematical studies, ultimately leading to improved academic performance for such children (Ata-Aktürk & Demircan, 2021; Star & Pollack, 2015). Pre-schoolers who have difficulty keeping their emotions in check may have difficulty focusing on what is being taught in the classroom, which might hinder their capacity to understand and remember the fundamentals of mathematical ideas.One argument that has been put up to explain the association between inhibition and the development of mathematical knowledge is that inhibition plays a role in regulating working memory (Shaul & Schwartz, 2014; TreffersDaller et al., 2020). It has also been shown that inhibition im-proves the ability to switch tasks and cognitive flexibility, essential mental talents for acquiring a mathematical education.This conclusion is consistent with what researchers already know about the role that inhibition plays in acquiring mathematical knowledge from prior studies. Learning both the subject and the abilities associated with mathematics requires a significant amount of concentration, as well as the ability to dismiss information that is not relevant (Ha, 2022; Tsai, 2020).Given the possibility that cultural factors influence how children acquire knowledge and develop executive functions, it is recommended that future research investigate the links between inhibition and the learning of mathematics across various cultural contexts and age ranges (Alkubaidi, 2014; Kim et al., 2014). In conclusion, the findings of this research indicate that inhibition is an essential mental activity that contributes to understanding mathematical principles (Star & Pollack, 2015).

Flexibility is Significantly Related to Mathematics Learning Difficulties

Much data points to a relationship between flexibility and difficulty learning mathematics. he fundamental reason for the mathematical problems experienced by Chinese pre-schoolers is their inability to adjust to new situations.One definition of flexibility is the capacity to adapt one's focus and mental strategy in response to changes in specific work requirements (Mulenga & Marbán, 2020). Students who are exposed to mathematical concepts that are progressively more difficult and who find that they need to modify their strategy for the solution of mathematical problems may conclude that flexibility is of particular significance in the context of their mathematics studies (Lee et al., 2020). Treatments that encourage the development of flexible thinking abilities may be advantageous for kids who struggle with mathematics because they help pupils become more adaptive and better prepared to tackle the problems of studying mathematics. Pre-schoolers may benefit from being more adaptive and more prepared to tackle these obstacles with the aid of these therapies (Al Hourani, 2019; Davidescu et al., 2020). These results are consistent with those of earlier studies that showed the importance of executive functions in developing young children's mathematics abilities (TAN Yuen Ling et al., 2020). Flexibility is an executive function that plays a significant role in cognitive flexibility, the ability to solve problems, and the ability to transition between different activities. According to the findings of the study, interventions that inspire children to think creatively may be beneficial to the mathematical success of children (Garrison & Vaughan, 2008; Pratiwi et al., 2021). In a nutshell, the outcomes of this research lend credence to the hypothesis that Chinese pre-schoolers' problems with mathematics may be traced back to a significant deficit in their capacity for flexibility (Verschaffel et al., 2011).

Conclusion

In sum, this research aimed to investigate, among Chinese preschoolers, the relationships between working memory, inhibition, flexibility and mathematical ability. The results of this research add to our expanding understanding of the mental processes at play in teaching students from disadvantaged backgrounds in mathematics. It seems that the degrees of inhibition and flexibility shown by Chinese preschoolers are essential predictors of difficulty acquiring mathematics skills. On the other hand, working memory did not demonstrate a statistically significant association with difficulty in mathematics. This research has flaws, such as the fact that it is a cross-sectional study, the sample size is not particularly large or diverse, In addition, instead than doing cross-sectional research, one might instead use longitudinal designs to shed light on the probable causal relationships between variables over time. In the future, the efficacy of various interventions may be evaluated to see which strategies are most successful for assisting certain types of students who are having difficulty. The findings of the study and the proposed directions for additional research should be considered by educators, parents, and lawmakers interested in improving the quality of mathematics teaching and providing assistance to students who are suffering.

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