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The Relationship Between Basic Cognitive Skills and Math Learning Disabilities in The First Grade

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ABSTRACT

This study investigates the relationship between five basic cognitive skills related to math lessons in Grade 1 of basic education: mathematical, numerical, analytical, classification, and measuring skills. The study will focus on three provinces of Kurdistan (Erbil, Sulaymani, and Halabja) and uses the descriptive method. Measuring phenomena depends on the criterion-referenced test. A specified grade is made to the criterion Reference that each participant can reach that grade. The study's results illustrated poor cognitive skills and learning difficulties in mathematics. Furthermore, 233 of 384 participants (60.68%) have poor cognitive skills in mathematics and a learning disability in the subject. The results indicate poor cognitive skills and significant gender differences between males and females. No statistically-significant differences were found in cognitive skills between provinces.

1. Introduction

According to psychoanalytic and other theories, the foundation of a child's personality at the beginning of basic school age (McLeod, 2018; Boulanger, 2015; Poenaru, 2018). A child's school and learning environment also affects the development of their intellect, knowledge and personality (Rogers & Kutnick, 1992; Marir, 2017). At this stage, students face several learning problems, some of which relate to environmental factors (Zughayer, 2010) while others relate to cognitive factors and skills. Many studies have found that weaknesses in basic cognitive skills make it difficult to learn most subjects, especially mathematics which requires constant attention, high levels of intelligence, abstract thinking, and the ability to accumulate and count (Gallistel & Gelman, 1992; Levine, Jordan & Huttenlocher, 1992; Fuson, Richards & Briars, 1982; Fuson et al., 1997; Desoete & Roeyers, 2002; Desoete & Roeyers, 2006).

Some studies have shown that the cognitive processes of perception, memory and logical thinking are the most important basic cognitive skills related to mathematics and mathematical problem-solving. In this regard, Mercer (1997) identified three main aspects of the field of perception that affect a learner's ability to analyse and implement mathematical processes: figure-ground differentiation, visual and auditory discrimination, and spatial orientation. Other studies have found that learning difficulties in mathematics relate to memory problems. Students who have short-term memory deficiencies frequently forget basic number facts in all four arithmetic processes, despite many efforts. They have difficulty answering simple questions such as 5+7=12 and 6×4=24 and often rely on their fingers to count their results (Garnett, 1998). Children with spatial visual memory problems also often suffer from mathematical learning difficulties, as Szucs et al. (2013) demonstrated.

A number of studies have studied the relationship between mathematical learning difficulties and general cognitive abilities such as intelligence, working memory and processing speed (Ackerman et al., 2005; Conway et al., 2002). However, other studies have linked the problem to spatial memory, visualization, directionality, working memory, sequential processing, selective attention, planning and reasoning. Each of these skills relates to an important aspect of mathematics (Egan, 2018).

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Research into the relationship of cognitive skills to academic achievement in mathematics and mathematical learning difficulties has taken various forms. Some studies have identified relationships between conceptual images and mathematical pyramid classification and hierarchy skills, parallels, and geometric objects in mathematics at different stages of education (Birgin & Özkan, 2022). Other studies have found a relationship between numerical skills and mathematics in kindergarten and the beginning of primary school (Aunio & Räsänen, 2016; Gashaj, Oberer, Mast & Roebers, 2019). Korolova & Zeidmane (2016) and Kunpol (2015) highlighted the relationship between applied mathematics and the development of analytical skills and their bilateral effects on each other. However, Gourgey (1982) studied the relationship between measurement skills in mathematics and mathematics anxiety.

This study aims to identify the level of basic cognitive skills in mathematics lessons among first-grade primary school students, which includes mathematical, numerical, analytical, classification and measuring skills. It will take the variables of gender and location into account. Information about these five skills is shown in Figure 1 below:

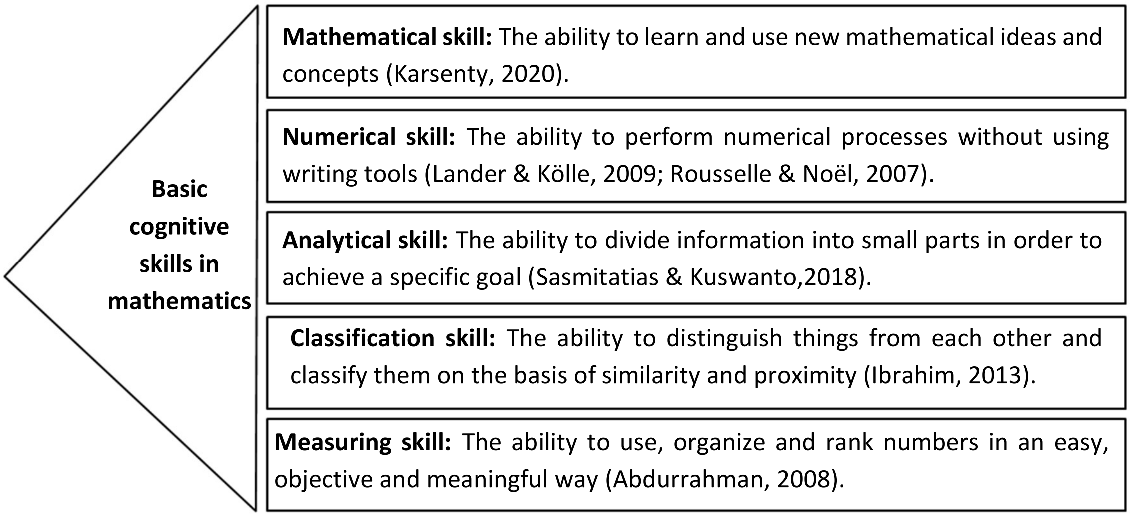

Figure 1: Five basic cognitive skills in mathematics (Karsenty, 2020; Lander & Kölle, 2009; Rousselle & Noël, 2007; Sasmitatias & Kuswanto, 2018; Ibrahim, 2013; Abdurrahman, 2008).

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2. Methodology

This section will outline the participants and the tools used in this paper. The descriptive method was selected for this study because it is appropriate to the nature of the research topic and able to address the research questions.

2.1. Population

The population of this study includes all first-grade students in Erbil, Sulaimani, and Halabja, which are three provinces of the Kurdistan Region. However, the research community consists of all first-grade students from seven education directorates in the three provinces. This includes the central education directorate in the centre of Erbil, the Soran and Rawanduz education directorates in Soran and Ruandz (towns in Erbil), the Western Education Directorate (in the centre Sulaimani city) and the two education directorates of Ranya and Pishder (in Ranya and Qaladze, towns in Sulaimani), as well as the education directorate of Halabja (in the centre of Halabja). According to the annual statistics of the Ministry of Education of the Kurdistan Regional Government, 25,451 students were enrolled in the academic year 2021-2022. As shown in Table 1

Table 1: Population data

Locality	Education Directorate	Number of students	
		Male	Female
Erbil	Erbil Centre Education Directorate	290	245
	Soran Education Directorate	1502	1441
	Rawanduz Education Directorate	474	423
Sulaimani	Western Education Directorate	5594	5466
	Ranya Education Directorate	2656	2546
	Pishdar Education Directorate	1415	1245
Halabja	Halabja Education Directorate	1086	1107
Total	25451		

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2.2. Participants

384 male and female first-grade basic school students participated in this study. They were randomly selected from the boundaries of the seven education directorates of the three provinces using cluster sampling. In determining the sample size, the study relied on (Sekaran & Bougie, 2016; Krejcie & Morgan, 1970; Saunders, Lewis & Thornhill, 2003; Thompson, 2012). As shown in Table2.

Table2: The sample size of the study by gender and locality

N	Variables	Category		Number	Percentage	Total size
1	Gender	Male		220	57.30	384
		Female		164	42.70	
2	Locality	Erbil	Erbil Centre Education Directorate	168	43.75	384
			Soran Education Directorate			
			Rawanduz Education Directorate			
		Sulaimani	Western Education Directorate	168	43.75	
			Ranya Education Directorate			
			Pishdar Education Directorate			
		Halabja	Halabja Education Directorate	48	12.5	

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2.3. Measuring instrument

The study used the scale Al-Waqfi (2012) prepared in Arabic, which measures seven basic cognitive skills through ten mathematical questions: mathematical, numerical, analytical, classification and measuring skills. The scale is the Criterion Referenced Test. A score is used to pass each question, meaning it evaluates the student's performance in light of a certain score and percentage.

The scale was translated from Arabic to Kurdish and then standardized and adapted to the Kurdistan educational environment. The adaptation was based on the first grade mathematics curriculum in Kurdistan basic schools, which was decided by the Kurdistan Regional Government's Ministry of Education. Mathematics subjects that were on the scale but not in the curriculum were removed and subjects that were not in the scale but were in the program were included in the scale according to the grades. Questions were changed, added and removed, and a number of measures and counting items were modified. This brings the number of questions to 13. After separating the repeated questions that come in types (A) and (B) and selecting one and removing the other, 10 questions were included in the final version.

2.3.1. Cut Score

The cut score is the score that each participant should reach on the measurer (Meskauskas, 1976), for this purpose, the study used the Angoff method (Angeff, 1971). However, the cut score of the questions is determined in the measuring instrument. The cut score of each of the five skills and overall cut score has been extracted based on the Angoff method, as shown in Table 3 below.

Table3: Cut score of measuring instrument

Skills	Questions	Q. Cut score %	Sk.Cut score %
Mathematical skills	Q1	75	75
Numerical skills	Q2	100	100
	Q3	100	
	Q4	100	

	Q5	100	
Analytical skills	Q6	80	80
	Q7	80	
Classification skills	Q8	67	67
Measuring skills	Q9	67	83
	Q10	100	
Cut score		**81%**	

2.3.2. Exploratory testing

In order to ensure the clarity of the measuring instrument questions and determine the time required to answer, a pilot study was implemented on a sample of primary school students in Soran City. The sample consisted of 38 students of both sexes who were selected in a random cluster from four primary schools in Soran. No obstacles to the implementation of the measurement tool were found related to the vagueness and difficulty of the research measurement questions. Response times were 41-50 minutes, with an average of 45 minutes after determining the completion time of the first participant and the last participant.

2.3.3. Validity

In order to ensure the research instrument would be able to accurately measure the subject, this study used translation validity, face validity and predictive validity.

The research measuring instrument was translated from Arabic to Kurdish, and the translation validity for the measurement was extracted in several steps in order to ensure the translation was accurate. Firstly, an expert in both the Arabic and Kurdish languages translated the text from Arabic into Kurdish. Secondly, another expert in both Arabic and Kurdish translated the Kurdish text into Arabic. Thirdly, another Arabic expert reviewed and compared the two Arabic texts. Finally, it was found that the two texts were 95% similar and there were no differences in meaning between them. The rate of translation validity was deemed to be high, and the decision was made to apply the measuring instrument to the study sample participants.

The face validity relied upon the opinions of 15 experts in the fields of psychology, mathematics and pedagogy, including university teachers and educational supervisors. To ensure the accuracy of the changes and the content of the measuring instrument, the study relied on the agreement rate of experts on the content of the scale. Chi-squared was used to determine the extent to which different experts agreed about the accuracy of the content and to identify the evidence of the questions of the measuring instrument. For this purpose, the resulting Chi-squared value of the questions was compared with the tabular value (3.84) and the significance level (0.05). If any question has a Chi-squared value less than the value of Table 3.84, it will be removed (Turner, 2014, p. 9). As a result, all the questions of the measuring instrument have statistical evidence. Because all the questions were approved, the content truth and the rate of agreement of experts on the questions of the measurement were high and appropriate, as shown in Table 4 below.

Table 4 : The face validity by Chi-squared values for the measuring instrument questions

Questions	Number of satisfied experts	Chi-Squared X2	Tabular value	Significance level	%
1,2,3,4,5,6,7,8,9,10	15	15	3.84	0,05	100

Predictive validity was also used to ensure the measuring instrument is valid. The measuring instrument was used with 38 students in four primary schools in Soran City. Each student scored a grade on the test, then their grades were compared with the grade and percentage of the final exam in mathematics. The relationship between them was then calculated using simple linear regression (Enter). The results demonstrated that the grades of all students on the mathematics examination were equal or very close to the grades obtained on the test (measuring instrument). This shows that the predictive ability of the measuring instrument is very high, as shown in Table 5 below.

Table 5: The predictive validity for the measuring instrument using simple linear regression

Model		**ANOVA**		**Coefficients**			
Variables	R2	F	P.Sig	B0	B1	T	P.Sig
Test / Exam	0.97.5	1402.537	0.00	-3.780	1.045	37.450	0.00

The regression coefficient result showed that the value of R2=0.97.5, meaning the measure has a predictive ability of 97.5% and the final grades of the exam affect the test grade. The value of F=1405.537, P=0.00>0.05 means that there is statistical evidence for the relationship between them. The value of (B0=-3.788, B1=1.045), means the regression equation is (Y=-7.683+1.080. X). The value (T=37.450, P=0.00>0.05) shows a strong positive relationship between the two variables, and that the higher the grade on the final math exam, the higher the grades on (measuring instrument) the test. This can be seen in Figure 2 below.

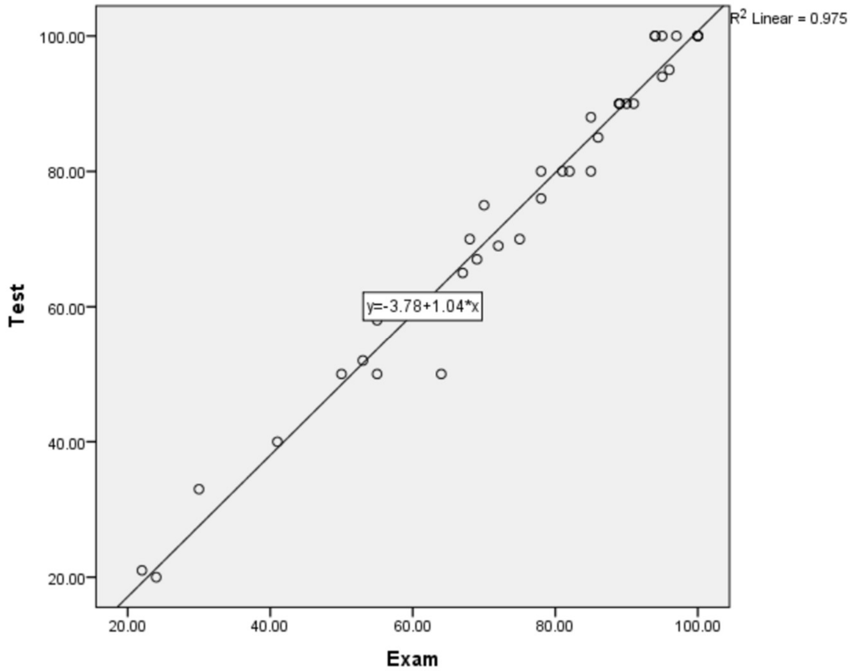

Figure 2: The direct relationship between test grades and final exam grades in math using simple linear regression

2.3.4. Reliability

To determine reliability in this study, the equivalent forms method was used relying on the Cohen's kappa coefficient. This relies on two different measures in terms of shape and form, such as forms (A) and (B), which are similar in content. In order to determine the relationship between the grades of the first (A) and second (B) test and the constant and reliability between them, the first measurement in form (A) was distributed to a group of 38 students. The sample was randomly selected from four primary schools in Soran. After completing the test, the students were given a short rest. The second measurement in form (B), which is similar in content to the first measurement (A) and contains the same number of questions in a different form, was then administered to the same group of participants. The correlation between the grades of the two tests was then found using Cohen's kappa coefficient.

The results demonstrate the number of observed agreements (po=0.94), number of agreements expected by chance (pe=0.49), and the kappa coefficient (Kappa= 0.895) with a 95% confidence level. This result is evidence of the existence of similarity and substantial agreement between the first and second measurements, according to the criterion defined by Shrout (1998), Holle & Rein (2013) and Landis & Koch (1977). The presence of reliability in the first measurement and at the same time high validity and reliability in the second measurement can be used as the first measurement to measure the subject.

Table 6: Reliability of the measuring instrument using the Cohen's kappa coefficient

Test B / Test A		Groups		Total
		Agreements	**Disagreements**	
Groups	**Agreement**	0.47	0	0.47
	Disagreements	0.07	0.47	0.53
Total		0.53	0.47	100

2.3.5. Applying the measuring instrument

After ensuring the validity and reliability of the measuring instrument, it was applied to the final sample in primary schools in Erbil city centre and Rawanduz districts, the Soran districts of Erbil, the Sulaimani centre and Ranya districts, the Qaladze districts of Sulaimani, and the primary schools in central Halabja. The process began in December 2021 and was completed in April 2022.

3. Results

Our results illustrated poor cognitive skills and learning disability in mathematics. 233 of 384 participants (60.68%) were found to have poor cognitive skills in mathematics and a learning disability. The pass rate of classification skills was the highest among the study sample participants, but the pass rate of analytical skills was the lowest, as shown in Table 7 below.

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Table 7: Level of basic cognitive skills of the study sample

Cognitive Skills	Result				Total size
	Pass		Fail		
	N	%	N	%	
Mathematical	309	80.47	75	19.53	384
Numerical	168	43.75	216	56.25	
Analytical	171	44.53	213	55.47	
Classification	331	86.20	53	13.80	
Measuring	291	75.79	93	23.21	
5 Skills	151	39.32	233	60.68	

The results also showed that males have significantly higher levels of basic cognitive skills in mathematics than females, and females have higher learning disability in mathematics than males, as shown in Table 8 below.

Table 8: Level of basic cognitive skills by gender

Gender	N	%	Result				Total size
			Pass		Fail		
			N	%	N	%	
Male	220	57.30	131	34.11	89	23.18	384
Female	164	42.70	20	5.20	144	37.5	

For the location variable, the study found no significant differences between the students of Basic schools in the three provinces. The level of cognitive skills in mathematics in the study sample is generally low, and the learning disability in the subject is high, as shown in Table 9 below.

Table 9: level of basic cognitive skills by locality

Location	N	%	Result				Total size
			Pass		Fail		
			N	%	N	%	
Erbil	168	43.75	71	42.26	97	57.74	384
Sulaimani	168	43.75	58	34.52	110	65.48	
Halabja	48	12.5	22	45.84	26	54.16	

4. Discussion

We found a high rate of weak cognitive skills in mathematics and learning difficulties in the study sample. Mathematical learning disabilities in the first grade of basic schools in Kurdistan are related to weak mathematical, numerical, analytical, classification and measurement skills. This is consistent with studies that have investigated cognitive skills and motivation and their relationship to mathematics and mathematical learning difficulties (Desoete & Roeyers, 2005; Cowan, Hurry & Midouhas, 2018; Ling & Loh, 2021). Our results are also consistent with studies that have found associations between analytical skills and mathematics (Korolova & Zeidmane, 2016; Kunpol, 2015). They are also consistent with Birgin & Özkan (2022), who emphasized the relationship between classification skills and mathematics. However, our findings do not support other studies that have denied this relationship (Douglas & LeFevre, 2018).

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We found that males had higher cognitive abilities in mathematics and fewer learning disabilities than females. This result is consistent with Sowell et al. (2007), Zaidi (2010) and Raz et al. (2001) who studied the differences between men and women in mathematical skills, and attributed these differences to men's larger and more developed brains. We also found that the level of cognitive skills and learning difficulties in mathematics varied slightly from one province to another, but the difference is not large and the results are very similar. Our findings are consistent with studies that emphasize the lack of differences in cognitive skills and learning difficulties in mathematics from place to place, including Kane & Mertz (2012) who found no differences in mathematical ability between learners based on location. However, our findings do not support other studies that have found a relationship between place and mathematics, such as Nepal (2016) and Bolton (2019).

5. Conclusion

We found a high rate of weak cognitive mathematical skills among the study sample, as well as a weak association between basic cognitive skills and mathematical learning disabilities. However, mathematical learning difficulties may also be related to a number of environmental and instructional factors, some of which may be related to the student and their orientation to the subject, and some to the teacher and teacher incompetence. All of these factors need to be investigated further.

Our findings on gendered differences in mathematical abilities are consistent with many studies that attribute these to differences in brain structure. The problem itself has not been fully resolved. Our results support studies that have found no relationship between location and mathematical ability, but are not consistent with studies that have found a relationship between mathematics and location or geographical environment. While this area has been subject to much discussion and research, as yet there is no consensus.

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پەیوەندی نێوان کارامەییە مەعریفیە بنەڕەتیەکان و ئاستەنگیەکانی فێربوون لە بیرکاری لە پۆلی یەکەم

پـوختـە:

ئەم توێژینەوەیە هەوڵی داوە لە پەیوەندی پێنج کارامەیی مەعریفی بنەڕەتی کە بریتین لە کارامەییەکانی (بیرکاری، ژمێرەیی، شیکاری، پۆلێنکاری، پێوانەکاری) بە وانەی بیرکاری لە پۆلی یەکەمی بنەڕەتی بکۆڵێتەوە. توێژینەوەکە پەیرەوی لە میتۆدی وەسفت کردووەو کۆمەڵگای توێژینەوەش سێ پارێزگای هەرێمی کوردستان (هەولێر، سلێمانی، هەڵەبجە) لەخۆگرتووە، بە مەبەستی پێوانکردنی دیاردەکەش پشتی پێوانکارێکی سەنگی-مەحەکی بەستووە کە تیایدا نمرەیەکی دیاریکراو کراوەتە سەنگی مەحەک بۆ ئەوەی هەر بەشداربووێک بەو نمرەیە بگات. ئەنجامی توێژینەوەکە ئاستێکی بەرزی لاوازی کارامییە مەعریفیەکان و ئاستەنگی فێربوونی لە وانەی بیرکاری لای نموونەی توێژینەوەکە دەرخستووە، بەجۆرێک لەکۆی (384) بەشداربوو،(233) بەشداربوو بە ڕێژەی (60.68%) کێشەی لاوازی کارامەیی مەعریفی لە بیرکاری و ئاستەنگی فێربوونیان لە بابەتەکەدا هەیە. هەروەها ئەنجامی توێژینەوەکە ئاماژەی بە بوونی جیاوازی لە نێوان ڕەگەزی نێرو مێ و نەبوونی جیاوازی ئاستی کارامەییە مەعریفیەکان و ئاستەنگی فێربوون لە بیرکاری لە نێوان سێ پارێزگاکە کردووە.

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العلاقة بين المهارات المعرفية الأساسية وصعوبات تعلم الرياضيات في الصف الأول

الملخص:

حاول هذا البحث معرفة العلاقة بين خمس مهارات معرفية أساسية وهي المهارات الرياضية، المهارات العددية، المهارات التحليلية, مهارات التصنيف، ومهارات القياس المتعلقة بدرس الرياضيات في الصف الاول الأساسي. اتبع البحث المنهج الوصفي، وشمل مجتمع البحث ثلاث محافظات لإقليم كوردستان (أربيل، السليمانية، حلبجة). من حيث قياس الظاهرة اعتمد البحث على الاختبار المحكي المرجعي والتي من خلالها يتم وضع تقدير محدد لمرجع المعيار الذي يمكن لكل مشارك الوصول إلى هذا المستوى. أوضحت نتائج الدراسة وجود مستوى عال من ضعف المهارات المعرفية وصعوبات في تعلم مادة الرياضيات لدى العينة، وأشارت النتائج بأن من بين ٣٨٤ مشاركا أظهر ٢٣٣ منهم وبنسبة (٦٠.٦٨٪) توجد لديهم ضعف في المهارات المعرفية في الرياضيات وصعوبات التعلم في المادة. كما أشارت نتائج الدراسة إلى وجود فروق بين الذكور والإناث وعدم وجود فروق بين المحافظات الثلاث في مستوى المهارات المعرفية الاساسية في الرياضيات و وصعوبات التعلم في المادة.