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Prevalence of Dyscalculia Among Fourth-Grade Students in Algerian Primary Schools: The Impact of School Type and Gender

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Abstract:
This study aims to examine the prevalence of mathematical difficulties (dyscalculia) among fourth-grade students in Algerian primary schools, with a focus on the potential effects of school type and gender on the severity of these difficulties. The study involved 30 male and female students aged between 9 and 11 years, selected from two schools in different cities. The researchers used an assessment tool consisting of 12 questions covering basic arithmetic operations such as ordering, addition, subtraction, multiplication, division, and problem-solving. Data were analyzed using the Friedman test to identify differences in mathematical errors based on the type of operation, and the Mann-Whitney test to detect gender differences. The results revealed significant differences in the types of errors related to arithmetic operations, with errors being more common in subtraction and addition compared to other operations. However, no significant gender differences were found in the mathematical errors. Based on these findings, the study recommends the development of specialized teaching strategies to meet the needs of students with mathematical difficulties, with an emphasis on early interventions.
Keywords: Dyscalculia, mathematical difficulties, Primary school.

Introduction:

Dyscalculia, a neurodevelopmental disorder, disrupts the brain's ability to accurately and efficiently comprehend and process numerical information (Estévez-Pérez, Sanabria-Díaz, Castro-Cañizares, Reigosa-Crespo, & Melie-García, 2023) . Marked by difficulties in developing number sense, acquiring basic math facts, performing calculations, and engaging in mathematical reasoning, dyscalculia requires that a child's mathematical performance be significantly below age expectations. This underperformance must not be attributed to insufficient educational opportunities or sensory or intellectual impairments and must interfere with academic or professional functioning and daily life. A diagnosis also necessitates that the difficulties persist for at least six months despite targeted interventions(Estévez-Pérez et al., 2023).

Dyscalculia is prevalent, affecting an estimated 2.5% to 6.4% of school-age children(Reigosa-Crespo et al., 2012), and it often coexists with other neurodevelopmental disorders, particularly dyslexia, with comorbidity rates ranging from 10% to 70% (Wilson et al., 2015). In some cases, dyscalculia can be detected in early schooling, although its effects may not be fully apparent until academic demands exceed the individual's limited mathematical abilities. This can have a substantial impact on socio-economic outcomes in adulthood (Estévez-Pérez et al., 2023).

Research indicates that dyscalculia stems from deficits in working memory (WM), particularly in visuospatial WM, which is essential for representing and manipulating quantities on a mental number line. These WM impairments affect core numerical skills, including magnitude judgment, enumeration, and subitizing, and are evident even when children with dyscalculia are matched with typically developing peers on measures of general intelligence and cognitive abilities (Menon, 2016).

Neuroimaging studies reveal specific structural and functional abnormalities in regions responsible for mathematical processing, notably in the intraparietal sulcus (IPS) and parietal cortex, which play critical roles in numerical cognition. For example, children with dyscalculia exhibit atypical activation patterns in these areas, suggesting a disruption in both domain-specific and domain-general processing networks (Landerl, Vogel, & Grabner, 2021). Additionally, studies suggest that altered connectivity patterns, especially within the parietal and

frontal brain regions, may contribute to dyscalculia's profile, leading researchers to categorize it as a "disconnection syndrome" (Rykhlevskaia, Uddin, Kondos, & Menon, 2009).

The genetic basis of dyscalculia is supported by familial prevalence studies, which show high rates of the disorder among relatives (Shalev et al., 2001). The “number sense” hypothesis suggests that the disorder may arise from deficits in the approximate number system—a core numerical representation system critical for processing quantities. In contrast, the “access deficit” hypothesis posits that dyscalculia results from difficulty linking numerical symbols with their respective quantities, despite having intact non-verbal processing (Rousselle & Noël, 2007).

Addressing dyscalculia often involves interventions focused on strengthening visuospatial and executive functions, with tailored educational strategies like visualization tools and calculators to aid in arithmetic learning (Shalev & Gross-Tsur, 2001). Longitudinal studies reveal that dyscalculia typically persists from childhood through adolescence, impacting both academic success and everyday functional skills, underscoring the need for early intervention and continued support to improve long-term outcomes (Kucian & von Aster, 2015)

Dyscalculia, a specific learning disorder affecting mathematical abilities, poses significant challenges for students, particularly in early education. This disorder can manifest as difficulty with number sense, arithmetic operations, and mathematical reasoning, leading to substantial academic and social consequences (Sayeski, 2023). Several factors contribute to dyscalculia in students, including limited teaching methods, individual cognitive differences, and inadequate resources. Research highlights that traditional instructional methods may not accommodate the diverse learning needs of dyscalculic students, with studies suggesting that varied teaching strategies and engaging educational tools, such as interactive software, can enhance learning outcomes(Mursyida, Ginting, Aprillia, & Kurnia, 2023). In the context of Algerian primary schools, high rates of dyscalculia have been reported among third-grade students, with gender and school differences impacting its prevalence (Boudiaf & kachar,2022). This finding underscores the need for comprehensive and tailored interventions that consider cultural and institutional factors. Furthermore, integrating traditional games into the curriculum has been shown to improve students’ motivation and self-concept, thereby supporting mathematical learning (Venketsamy & Hu, 2023; Choaib & Roslan,2015). Studies also indicate that dyscalculia often coexists with other cognitive challenges, such as math anxiety and low self-esteem, which can predict its persistence (Choaib& Roslan,2015).Effective interventions for dyscalculia emphasize a multifaceted approach. Programs that incorporate visual aids, color coding, and adaptive exercises have been effective in enhancing engagement and mathematical skills (Mukherjee et al., 2024). These approaches highlight the importance of early identification and personalized support in mitigating the negative academic and social impacts of dyscalculia.

Current study

Despite extensive research on dyscalculia and its impact on students' mathematical abilities, there remains a significant gap in understanding how this disorder manifests across diverse educational and cultural settings, particularly outside Western contexts. Most studies focus on Western populations, leaving a need to explore dyscalculia’s prevalence, effects, and effective interventions within different cultural frameworks, such as Algerian primary schools. High rates of dyscalculia have been observed among third-grade students in Algeria, with evidence suggesting that factors like gender and school type may influence its prevalence (Boudiaf & kachar,2022). However, research on culturally responsive strategies, such as incorporating traditional games to enhance motivation and self-esteem, is limited in this setting. This study thus seeks to investigate the prevalence of dyscalculia among fourth-grade students in Algeria, examining whether statistically significant differences exist based on gender and school type. What are the prevalence rates of dyscalculia among these students, and are there significant gender differences?

Method

1. Study Sample

The study sample consisted of 30 fourth-grade students, both boys and girls, with ages ranging from 9 to 11 years. The students were selected from two elementary schools: LamardKhedir School in M’sila and Ketfi Ismail School in Sétif.

2. Research Tool

The Arithmetic Disability Scale, developed by (Aityahya,n.2009 ،), is an assessment tool designed to evaluate students' proficiency in arithmetic. The tool comprises ten main exercises that focus on fundamental arithmetic operations such as addition, subtraction, multiplication, and division. These exercises are designed to assess students' ability to handle basic mathematical tasks, such as ordering numbers and comparing values.

The tasks are structured in increasing levels of complexity, ranging from basic operations to more advanced problem-solving exercises that require critical thinking and analytical skills. This allows the tool to evaluate not only the accuracy of the students' calculations but also their ability to interpret and process numerical information.

The scale is flexible and can be used across various educational stages, making it a versatile tool for assessing arithmetic skills in a wide range of student populations. The reliability and validity of the tool have been established through its careful design, ensuring that it accurately measures arithmetic abilities and provides consistent results.

3. Statistical Analysis

Statistical analysis is essential in scientific research to accurately test the study's hypotheses. The following statistical methods were applied:

Friedman Test: Used to determine the presence of statistically significant differences between the means of the measurements.

Mann-Whitney U Test: A non-parametric test used to assess significant differences in rank averages of calculation errors based on the gender variable.

Results

Hypothesis 1: This hypothesis states, "Fourth-grade students encounter numerous difficulties and make various types of errors in arithmetic. These errors differ according to the type of operation (ordering, addition, subtraction, multiplication, division, and problem-solving)." To examine this hypothesis, we used the mean and standard deviation to categorize errors according to the type of arithmetic operation. The errors were ordered based on the type of operation (ordering, addition, subtraction, multiplication, division, and problem-solving) using the Friedman ranking test to sort the three main areas, yielding the results shown in the following table:

Table 1 shows the Friedman ranking test for the types of errors by arithmetic operation (ordering, addition, subtraction, multiplication, division, and problem-solving).

Classification	Errors by Type of Arithmetic Operation	Mean Rank	Chi-Square	Degree of Freedom	Significance Level	Decision
A	Problem-Solving	13.2	168.74	5	0.000	Significant at 0.01
B	Division	30.4				
C	Multiplication	27.5				
D	Subtraction	80.3				
E	Addition	48.3				
F	Ordering	2.02				

Based on the results in the table above and according to the mean ranks generated by the Friedman test for errors based on the type of operation, the following descending order of error types was observed:

Subtraction ranked first with a mean rank of 3.80.

Addition ranked second with a mean rank of 3.48.

Division ranked third with a mean rank of 4.30.

Multiplication ranked fourth with a mean rank of 5.27.

Problem-solving ranked fifth with a mean rank of 2.13.

Ordering ranked sixth with a mean rank of 2.02.

With a Chi-square value of 168.74, which is statistically significant at an alpha level of 0.01, we observe statistically significant differences in the ranking of errors by operation type (ordering, addition, subtraction,

multiplication, division, and problem-solving). To determine which operation ranked highest, the Wilcoxon signed-rank test was employed for pairwise comparisons, revealing differences in error ranking by operation type based on the Friedman mean ranks. The Wilcoxon test confirmed that the ranking obtained from the Friedman test accurately reflects the order of the six operations. Thus, we conclude that Hypothesis 1 is supported: Fourth-grade students encounter substantial difficulties and various types of errors in arithmetic, with errors varying by operation type. The order of these difficulties is as follows: Subtraction, Addition, Division, Multiplication, Problem-solving, and Ordering, as illustrated in the table above.

Table 02: Wilcoxon Test for Paired Comparisons to Rank Errors by Type of Mathematical Operation (Ordering, Addition, Subtraction, Multiplication, Division, and Problems)

Pair Comparison	Sample Size	Rank Type	Average Rank	Total Rank	Z-Value	Significance Level (p-value)	Decision
B - A	2	Negative Ranks	3.50	7.00	-4.493*	0.000	Significant
	25	Positive Ranks	14.84	371.00			
C - A	0	Negative Ranks	0.00	0.00	-4.968*	0.000	Significant
	29	Positive Ranks	15.00	435.00			
C - A	0	Negative Ranks	0.00	0.00	-4.516*	0.000	Significant
	26	Positive Ranks	13.50	351.00			
D - A	3	Negative Ranks	5.50	16.50	-3.873*	0.000	Significant
	21	Positive Ranks	13.50	283.50			
F - A	7	Negative Ranks	17.64	123.50	-1.823	0.068	Not Significant
	21	Positive Ranks	13.45	282.50			
C - B	1	Negative Ranks	3.50	3.50	-3.112*	0.002	Significant
	13	Positive Ranks	7.81	101.50			
E - B	17	Negative Ranks	13.59	231.00	-1.028	0.304	Not Significant
	10	Positive Ranks	14.70	147.00			
D - B	17	Negative Ranks	11.56	196.50	-2.330*	0.020	Significant
	5	Positive Ranks	11.30	56.50			
F - B	22	Negative Ranks	14.11	310.50	-3.443*	0.001	Significant
	4	Positive Ranks	10.13	40.50			
C - D	21	Negative Ranks	12.57	264.00	-3.897*	0.000	Significant

	2	Positive Ranks	6.00	12.00			
C - E	25	Negative Ranks	13.78	344.50	-4.353*	0.000	Significant
	1	Positive Ranks	6.50	6.50			
C - F	25	Negative Ranks	15.74	393.50	-4.360*	0.000	Significant
	3	Positive Ranks	4.17	12.50			
D - E	10	Negative Ranks	14.20	142.00	-1.411	0.158	Not Significant
	10	Positive Ranks	6.80	68.00			
D - F	24	Negative Ranks	17.15	411.50	-3.703*	0.000	Significant
	6	Positive Ranks	8.92	53.50			
E - F	21	Negative Ranks	13.14	276.00	-3.064*	0.002	Significant
	4	Positive Ranks	12.25	49.00			

Hypothesis 2:

This hypothesis states: "There are statistically significant differences in the mean rank scores of calculation errors according to the type of mathematical operation (ordering, addition, subtraction, multiplication, division, and word problems) among students with math difficulties, based on gender. To verify this hypothesis, the non-parametric Mann-Whitney test was used to determine the significance of differences in the mean rank scores of calculation errors according to gender. The results are presented in the following table:

Table 03 illustrates the Mann-Whitney test for the significance of differences in mean rank scores of calculation errors among students with math difficulties, based on gender.

Variable	Gender	Sample Size	Mean Rank	Sum of Ranks	U Mann-Whitney	Significance Level	Decision
Inquiry	Male	14	210.50	15.04	105,500	0.771	Not Significant at 0.05
	Female	16	254.50	15.91			
	Total	30					
Division	Male	14	186.50	13.32	81,500	0.179	Not Significant at 0.05
	Female	16	278.50	17.41			
	Total	30					
Multiplication	Male	14	201.00	14.36	96,000	0.481	Not Significant at 0.05
	Female	16	264.00	16.50			
	Total	30					
Subtraction	Male	14	210.00	15.00	105,000	0.764	Not Significant at 0.05
	Female	16	255.00	15.94			
	Total	30					
Sum	Male	14	219.50	15.68	109,500	0.916	Not Significant

							at 0.05
	Female	16	245.50	15.34			
	Total	30					
Ordering	Male	14	244.00	17.43	85,000	0.213	Not Significant at 0.05
	Female	16	221.00	13.81			
	Total	30					
Answer H	Male	14	205.00	14.64	100,000	0.617	Not Significant at 0.05
	Female	16	260.00	16.25			
	Total	30					
Answer S	Male	14	216.00	15.43	111,000	0.967	Not Significant at 0.05
	Female	16	249.00	15.56			
	Total	30					

The results in the above table indicate slight differences in the mean rank scores between genders (male/female) in the arithmetic operations test and its sub-dimensions (inquiry, division, multiplication, subtraction, addition, and ordering). These results also apply to the total score of incorrect answers and the total score of correct answers. The absence of significant differences in the previously mentioned operations, as well as in the total scores for incorrect and correct answers, is further supported by the U-values, which were as follows for the dimensions: 105,500 / 81,500 / 96,000 / 105,000 / 109,500 / 85,000 / 100,000 / 111,000. These values were not statistically significant at the significance level of $\alpha = 0.05$.

Consequently, we can reject the research hypothesis that states, "There are statistically significant differences in the mean rank scores of arithmetic errors according to the type of arithmetic operation (ordering, addition, subtraction, multiplication, division, and inquiry) among students with arithmetic difficulties based on gender." Instead, we accept the null hypothesis, which denies the existence of a difference. The confidence level in this result is 95%, with a margin of error of 5%.

In conclusion, the research hypothesis, which proposed that there are statistically significant differences in the mean rank scores of arithmetic errors based on the type of arithmetic operation (ordering, addition, subtraction, multiplication, division, and inquiry) among students with arithmetic difficulties based on gender, is not supported. We accept the null hypothesis, which denies the existence of such a difference.

Discussion

The findings of this study provide insights into the arithmetic challenges faced by fourth-grade students with dyscalculia, particularly in the Algerian educational context. Consistent with previous research, students with dyscalculia encountered difficulties across various types of arithmetic operations, with significant variations in error rates depending on the type of operation. The results of the Friedman test ranked subtraction as the most error-prone operation, followed by addition, division, multiplication, problem-solving, and finally ordering. This hierarchy of errors aligns with findings by Menon (2016) and Mukherjee et al. (2024), who highlighted that subtraction and addition tend to be more challenging for children with dyscalculia due to the complex cognitive processing required for these operations.

The absence of significant gender differences in error rates across operations, as determined by the Mann-Whitney test, adds an interesting dimension to our understanding of dyscalculia. This finding contradicts some studies that have found gender differences in math performance and cognitive processing (Shalev et al., 2001). However, the lack of gender differences in this sample suggests that dyscalculia's impact on arithmetic skills may be more universal, affecting boys and girls similarly. This could imply that interventions need not be gender-specific but should instead focus on addressing individual cognitive difficulties, such as working memory deficits highlighted by Kucian and von Aster (2015).

Moreover, this study reinforces the need for culturally responsive approaches to support students with dyscalculia. Research indicates that incorporating traditional games and visual aids can enhance motivation and engagement, particularly in non-Western contexts where standard educational tools may not align with cultural

practices (Venketsamy& Hu, 2023). The study's findings on error prevalence in Algerian primary schools emphasize the importance of tailored educational strategies, as suggested by Sayeski (2023) and Estévez-Pérez et al. (2023). These approaches may be particularly effective in settings where dyscalculia coexists with other challenges, such as math anxiety and low self-esteem (رسلان&شعيب, 2015).

In summary, the study's results underscore the need for early identification and intervention strategies to address arithmetic difficulties in children with dyscalculia. By focusing on specific error-prone operations and incorporating culturally relevant teaching tools, educators can better support students in overcoming their learning challenges. Future research should explore larger samples across diverse educational settings in Algeria to further validate these findings and refine intervention techniques for students with dyscalculia.

Conclusion and Recommendations

In conclusion, this study highlights the significant arithmetic challenges faced by fourth-grade students with dyscalculia in Algeria. The findings reveal that subtraction and addition are the most error-prone operations, underscoring the need for targeted support in these areas. The absence of gender differences in arithmetic error rates suggests that dyscalculia affects both boys and girls similarly, emphasizing the need for interventions that are universally applicable rather than gender-specific.

Recommendations

Targeted Intervention Programs: Educational institutions should implement targeted intervention programs focusing on subtraction and addition, as these are the most challenging operations for students with dyscalculia. Such programs should include repetitive exercises and practical activities to reinforce basic arithmetic skills.

Use of Culturally Relevant Teaching Tools: Incorporating traditional games, visual aids, and culturally relevant examples in teaching materials can help make arithmetic learning more engaging and accessible for students with dyscalculia, especially in non-Western contexts like Algeria.

Early Identification and Assessment: Schools should adopt early screening and assessment techniques to identify students with dyscalculia at an early stage. This can help provide timely support, minimizing the long-term academic and emotional impact of learning difficulties in mathematics.

Teacher Training: Teachers should be trained to recognize the signs of dyscalculia and to implement specialized teaching strategies. Professional development workshops focusing on dyscalculia can equip teachers with the skills needed to support students with arithmetic difficulties effectively.

Further Research: Future research should explore the effectiveness of various intervention methods in different Algerian educational settings. Studies with larger and more diverse samples can help validate these findings and contribute to the development of refined support strategies for students with dyscalculia.

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