Evaluating Executive Functions: Planning Strategies in Students with Dyscalculia- An Applied Study on a Sample of Third-Grade Primary Students

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Abstract

This study aims to evaluate a fundamental executive function, specifically the planning strategy, in third-grade primary students diagnosed with dyscalculia. Utilizing a case study approach, a deliberately chosen sample of five (5) students, ages 8 to 9 and identified with dyscalculia, was analyzed. For hypothesis validation, diagnostic subtests from the Zareki R battery and the complex Figure de Rey test were employed.

The outcomes revealed the presence of significant planning strategy disorders among the dyscalculic students. In light of these findings, it is recommended that further research be conducted to explore executive functions, particularly the planning strategy, within dyscalculic student populations to enhance their academic resilience and address the educational challenges posed by dyscalculia.

Keywords

Executive functions;
Planning strategy ;
Dyscalculia ;

تقييم الوظائف التنفيذية: إستراتيجية التخطيط لدى التلاميذ ذوي عسر الحساب- دراسة تطبيقية على عينة من تلاميذ الصف الثالث ابتدائي

ملخص

تهدف الدراسة الحالية إلى تقييم واحدة من أهم الوظائف التنفيذية ألا و هي إستراتيجية التخطيط لدى التلاميذ ذوي عسر الحساب لعينة من تلاميذ الصف الثالث الابتدائي، و قد تم اعتماد منهج دراسة الحالة على عينة منتقاة بطريقة قصدية قوامها خمسة(5)حالات تعاني من اضطرابات عسر الحساب تتراوح أعمارهم بين8 و9 سنوات، و للتأكد من صحة فرضياتنا تم تطبيق بعض الاختبارات الفرعية من بطارية Zareki Rلتشخيص عسر الحساب، و كذا اختبار شكل راي المعقد.Figure de Rey

أظهرت نتائج الدراسة وجود اضطرابات إستراتيجية التخطيط لدى التلاميذ ذوي عسر الحساب، و انطلاقا من هذه النتائج يوصي الباحثان بضرورة توسيع مجال الدراسة في ما يخص الوظائف التنفيذية لدى عسيري الحساب بشكل عام و إستراتيجية التخطيط على وجه التحديد لدعم هذه الفئة و مساعدتهم على تجاوز الصعوبات التحصيلية المترتبة عن اضطراب عسر الحساب.

الكلمات المفتاحية

الوظائف التنفيذية؛
إستراتيجية التخطيط ؛
عسر الحساب ؛

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1- Introduction:

Executive functions represent a collection of cognitive and behavioral skills essential for individuals to effectively navigate complex situations and problems. This term, a relatively recent addition to the lexicon of neuroscientific and cognitive sciences, denotes a series of cognitive operations that are activated to consciously regulate thought and action (Goswami, 2002), aimed primarily at aiding an individual's adaptation to novel and challenging environments and contexts. This cognitive construct encompasses various functions critical to directing behavior, including planning, cognitive flexibility, inhibition, emotional control, and working memory, among others (Zelazo and Müller, 2002).

From this perspective, the integral role of executive functions in fostering academic success among students becomes apparent (Luria, 1973). Although each executive function is unique and distinct from the others, they are characterized by their interconnectedness and integrative nature. According to Miyake (2000) and Davidson et al. (2006), each cognitive component plays a specific role in addressing various academic challenges that students face within their educational settings. Numerous studies have identified the planning strategy as a foundational executive function that students utilize to tackle mathematical and logical challenges.

Defined by Gaux et al. (2007) as the capability to organize behavior towards achieving a predetermined goal through controlled steps (Gaux et al., 2007, p. 49), the planning strategy involves selecting and structuring a sequence of actions optimally to fulfill an objective. This entails arranging and timing the various steps necessary to implement strategies effectively (Godefroy et al., 2008, p. 154).

Bull & Scerif (2001) recognize planning as a vital mechanism for evolving a student's cognitive processes, especially in the realm of solving diverse mathematical problems, whether arithmetic, algebraic, geometric, or analytical. This connection is supported further by the work of Chung et al. (2014), which found that the planning strategy serves as a predictive indicator of a student's potential difficulties with mathematical reasoning (Chung et al., 2014).

Moreover, Vanden Heuvel and colleagues (2005) observed a decrease in arithmetic performance among students showing deficiencies in planning functions, a correlation echoed by the study of Hooper and Williams (2005). This latter research highlighted the relationship between planning capabilities and mathematical skills, particularly in solving arithmetic problems, using the complex version of the Figure de Rey test to assess the planning strategy among a cohort of primary students (Hooper and Williams, 2005, p. 173).

Considering the robust evidence linking planning strategies with developmental learning difficulties in mathematics, the absence of Algerian studies exploring this relationship with dyscalculia is notable. This lacuna, considering the varied psychological, sociological, and cognitive dimensions, complicates any generalizations, thus emphasizing the need to investigate the specific association between the executive function of planning and the developmental disorder of dyscalculia. The central research question of this study is: Do third-grade primary students with dyscalculia exhibit impairments in planning strategies?

2-Study Objectives:

The primary aims of this research are:

To explore the nature of planning skills among third-grade primary students diagnosed with dyscalculia.

To assess the efficacy of planning strategies employed by the members of the study sample.

To offer tailored suggestions and strategic recommendations for both specialists in dyscalculia and stakeholders within the educational sector.

3-Study Significance:

The relevance of this research is underscored by the topic it addresses, dyscalculia and its interplay with one of the pivotal executive functions, planning. This study's importance is accentuated by several key aspects:

It reveals the specific challenges encountered by students with dyscalculia in the context of Algerian educational institutions.

It aims to equip practitioners specializing in dyscalculia care with a deeper understanding of this disorder, thereby facilitating the development of effective therapeutic and educational programs that enhance overall executive functioning, with a particular focus on planning strategies. This is intended to aid students in overcoming the mathematical challenges posed by dyscalculia.

It contributes valuable insights to the Algerian academic repository, enriching it with studies focusing on seldom-discussed variables.

4-Study Concepts:

Developmental dyscalculia is a developmental disorder that refers to deficits in acquiring numerical understanding and control over calculations. In other words, it involves difficulties in acquiring and mastering the various knowledge and skills necessary for mathematics, including counting, learning arithmetic operations (addition, subtraction, multiplication,

division), and solving algebraic or geometric problems. This disorder is cognitive in nature (Daffaure, Guedin, 2011, p. 12).

-Dyscalculia:

Dyscalculia refers to a dysfunction in logical skills, performing arithmetic operations, and difficulties in reasoning and deduction. It affects individuals of all age groups who do not suffer from intellectual disabilities (with normal intelligence) but exhibit specific difficulties in mathematics. These difficulties include numerical understanding, logical reasoning, and impairments in processing arithmetic and mathematical problems (Brain, 1997, p. 60).

These challenges manifest as a disturbance in quantitative thinking and deficiencies in understanding the logical or arithmetic processing stages of numerical problems. Individuals also experience difficulty integrating dimensions, weights, and areas, as well as a failure in logical planning to solve mathematical problems, whether algebraic or geometric (Van Ront et Maljac, 2008).

Therefore, according to our current study, dyscalculia is a disorder resulting from a deficiency in comprehending and applying mathematical concepts to solve arithmetic problems. Operationally, it is defined by the score that a student obtains in the Zareki-R test used to diagnose dyscalculia.

-Executive Functions:

As defined by Théro, H. (2015), this term encompasses a broad spectrum of cognitive processes essential for organizing behavior, solving problems, and navigating through unfamiliar scenarios. This includes, but is not limited to, planning strategies, cognitive flexibility, inhibition, categorization, and performance monitoring, which collectively facilitate effective adaptation and problem-solving (Théro, H., 2015, p. 123).

-Planning Strategy:

Planning, as defined by Chung et al. (2014), is the ability to select and organize optimal responses to a specific situation with the aim of achieving a particular goal. An individual combines and connects elements coherently to ensure that the set objectives are reached. The planning process relies on skills such as the ability to anticipate (predict), the ability to sequence tasks in a specific order, the ability to estimate the time required to complete the task, and the ability to control and direct cognitive activity to achieve the goal (Chung et al., 2014, p. 17).

Planning is a higher cognitive function and a strategy that organizes and directs an individual's behavior to solve problems through stages, including problem identification, goal setting, strategy building, plan execution, and plan monitoring and adjustment if necessary to achieve the desired goal. Operationally, it is the score a student obtains after applying the Figure de Rey test in its complex form.

5-Methodological Procedures of the Study:

5-1-Study Method:

Employing the case study method, this qualitative research approach is designed to collect comprehensive data about the cases under study, aiming to fully understand their characteristics and interpret them accurately through a systematic and scientific framework (Yin, 2009, p. 18).

5-2-Study Sample:

The sample consists of four third-grade primary students aged between 8 and 9 years, selected purposefully under the following criteria:

Students diagnosed with learning difficulties in mathematics (dyscalculic).

Students assessed to have average intelligence levels (without any cognitive impairments).

Students who demonstrate normal or average academic performance in subjects other than mathematics.

5-3- Study Boundaries:

- Spatial Boundaries:

This research was conducted at Saad Guermech Ali Primary School, strategically located in the central region of Skikda city. The choice of this location was due to its representative student population and accessibility, allowing for controlled observation and data collection.

B. Temporal Boundaries:

The fieldwork for this study was executed during the second semester of the 2023/2024 academic year, a period chosen to ensure that students were sufficiently adapted to their educational environment, thus providing more accurate and stable data regarding their cognitive functions.

5-4-Study Tools:

-Dyscalculia Test:

The Zareki-R battery was utilized as a fundamental tool for the detection and diagnosis of dyscalculia and related mathematical processing disorders. Adapted for the Algerian context by researcher L. Hassan in 2011 and subsequently renamed Zareki-R-A, this diagnostic battery comprises twelve (12) distinct tests.

Counting dots
Reverse verbal counting
Dictating numbers
Verbal mental calculation
Reading numbers
Number positioning on a vertical scale
Repeating numbers
Comparing two numbers presented verbally
Visual estimation of quantities
Contextual qualitative estimation of quantities
Verbally presented arithmetic problems
Comparing two written numbers

For the diagnosis of dyscalculia among the study sample, two tests from the current study were adopted:

-The Verbal Mental Calculation Test:

Corresponding to test 04 in the battery, which was employed to assess the pupils in addition operations (items 4/1 to 4/8), subtraction operations (items 4/9 to 4/16), and multiplication operations (items 4/17 to 4/22), as detailed in the following table:

Table 1: Oral Mental Arithmetic Test Items

Addition				**Subtraction**				**Multiplication**			
Operation	**Answer**	**Time**	**Points 0-1-2**	**Operation**	**Answer**	**Time**	**Points 0-1-2**	**Operation**	**Answer**	**Time**	**Points 0-1-2**
5+8				17−5				2×3			
6+12				14−6				5×4			
13+4				24−17				4×3			
7+9				19−6				6×2			
12+15				15−9				3×5			
19+13				25−12				4×4			
8+14				32−17				/			
25+17				18−11				/			

- Verbally Presented Arithmetic Problems Test:

This corresponds to test 11 from the Zareki-R battery. It consists of a series of mathematical problems (items 11/1 to 11/6) that are presented to the pupil verbally. The following table illustrates these problems:

Table 2: Verbal Arithmetic Problems Test Items

Item	**Time**	**Answer**	**Points** 0-1-2
11-1			
11-2			
11-3			
11-4			
11-5			
11-6			

-Verbal Problem Items:

Item 11-1: Layla has 8 marbles, gives some to Amin, now has three. How many did Layla give to Amin?
Item 11-2: Amin has 4 marbles, Layla has 9. How many more marbles does Layla have than Amin?
Item 11-3: Layla has 5 marbles, Amin has 3 fewer than Layla. How many does Amin have?
Item 11-4: Amin has 12 marbles, gives 5 to Layla. How many does he have now?
Item 11-5: Amin has a large number of marbles, gives 5 to Layla, and is left with 7. How many did he have initially?
Item 11-6: Amin has 16 marbles, 4 more than Layla. How many marbles does Layla have?

-Application Method:

-Oral Mental Arithmetic Test:

The child is asked to perform a series of arithmetic operations presented orally: addition, subtraction, and then multiplication, under the following conditions:
Presenting the items while respecting their sequence.
The student is not asked to write.
Each item may be repeated once.
Recording the time taken for each operation.

-Oral Arithmetic Problems Test:

Problems are presented orally to the student according to their sequence.
The student must be given enough time to think.
The problem may be repeated once.
Recording the time taken to respond.
Recording everything the student says and does.

-Scoring Method:

Oral Mental Arithmetic Test:
Correct answer → Two points (2).
Correct answer after repeating the operation → One point (1).
Wrong answer or no answer → Zero points (0).

-Oral Arithmetic Problems Test:

Correct answer → Two points (2).
Correct answer after repeating the problem → One point (1).
Wrong answer or no answer → Zero points (0)

-Planning Test:

This test utilizes the Figure de Rey, developed by researcher André Rey in 1942, to evaluate visual perceptual analysis and visual processing at the working memory level, and to assess planning strategies. The examinee is required to make a direct copy followed by a memory-based reproduction of a geometric figure (Figure A). There is also a simplified version known as Figure B. This test involves assembling a series of elements that differ in geometric shape or spatial positioning, necessitating the use of perceptual, analytical, and organizational abilities that rely on the individual's planning capabilities.

-Application Method:

Provide the examinee with a blank sheet of paper (21×30 cm) and six colored pencils.
Present the examinee with a sheet displaying the composite figure A (with the small diamond oriented downward).
Instruct the examinee to copy the figure onto the blank sheet of paper.

-Instruction:

"Draw this picture on the blank sheet of paper, and try not to leave out any elements from the picture."
Start the stopwatch simultaneously with handing over the pencil.
Closely observe the method of copying and the use of colors.
Upon completion, record the time taken for the task.
Allow a three-minute interval between the first phase (copying) and the second phase (memory-based reproduction).
After three minutes, provide the examinee with a new blank sheet and ask them to reproduce the figure from memory.
Record the time taken for the reproduction in sequence.
Note any changes in color usage, which indicate the strategy used in both copying and recalling.
-Scoring:
Scoring for both the copying and memory reproduction phases is as follows:
Presence of Element: Scored as 0 or 0.5
Accuracy of Element: Scored as 0 or 0.5
Position of Element: Scored as 1 (incorrect position) or 2 (correct position).
The overall score for each element (16 elements in total) is calculated as follows:
Overall Score = (Presence + Accuracy) × Position
The final test score is the sum of the overall scores for all sixteen elements. (Oualis, 2013, pp 99-110).

6- Results Analysis:

6-1- Results of the Zareki R-A Dyscalculia Test:

The following table presents the results of the two subtests from the Zareki battery in its Algerian version:
Results of the Verbally Presented Arithmetic Problems Test (6 problems).
Overall total of the results for the Verbally Presented Arithmetic Problems.
Time taken to complete all the arithmetic problems.
Overall total of the results for addition problems.
Time taken to complete addition problems.
Overall total of the results for subtraction problems.
Time taken to complete subtraction problems.
Overall total of the results for multiplication problems.
Time taken to complete multiplication problems.
Overall grand total of the results for addition, subtraction, and multiplication.
Overall grand total of the time taken to complete addition, subtraction, and multiplication.

Table 3: Raw Results from the Oral Mental Arithmetic Test

Case	Q1	Q2	Q3	Q4	Q5	Q6	Overall Total for Problems	Time Taken for Problems	Addition	Time Taken for Addition	Subtraction	Time Taken for Subtraction	Multiplication	Time Taken for Multiplication	Overall Total for Arithmetic Operations (+/-/×)	Total Time Taken for Arithmetic Operations
1	1	1	1	2	0	0	5	312	10	75	4	180	12	22	26	277
2	1	0	0	2	2	1	6	140	12	84	8	189	12	18	32	291
3	1	1	0	0	1	0	3	177	6	210	4	145	6	80	16	435
4	1	0	1	1	1	0	4	378	7	250	5					

-Quantitative Analysis for Case 1 (M.N):

After applying the two subtests from the Zareki-R-A battery, we obtained the following results:

A. For the Verbal Mental Arithmetic Test:

The case exhibited hesitation in providing answers for problems 1, 2, and 3. The case correctly solved the fourth mental arithmetic problem but failed in the fifth and sixth problems. Consequently, the total score for this test is five (5) out of a possible twelve (12) points. The total time taken to complete the test was 312 seconds, which is approximately 5 minutes and 12 seconds.

The case scored 10 points in the addition tasks with a total completion time of 75 seconds. For subtraction, the case scored 4 points with a longer completion time of 180 seconds. In multiplication, the case achieved 12 points with a total time of 26 seconds.

Table 4: Raw Results from the Verbal Arithmetic Problems Test

Case	Verbal Arithmetic Problems Test		Time Taken	Total Score for Verbal Problems Test	Total Time Taken for the Test
Case 1	1	1	240	**4**	**1416**
	2	1	220		
	3	1	241		
	4	0	240		
	5	1	235		
	6	0	240		
Case 2	1	2	60	**5**	**1206**
	2	1	198		
	3	0	240		
	4	1	175		
	5	0	293		
	6	1	240		
Case 3	1	2	75	**5**	**64**
	2	1	120		
	3	1	150		
	4	1	120		
	5	0	240		
	6	0	240		
Case 4	1	2	80	**6**	**1258**
	2	1	235		
	3	1	225		
	4	1	240		
	5	1	233		
	6	0	245		

- Verbal Arithmetic Problems Test:

The case, M.N., exhibited moderate to poor results in solving verbally presented arithmetic problems. For problems 1, 2, and 3, the case scored one point each, with a time range of 220-241 seconds, respectively. In the fourth problem, despite taking 240 seconds, the case failed to solve it. The case scored one point in the fifth problem, taking 235 seconds, and failed to solve the sixth problem, scoring zero points with a time of 240 seconds. The total score for this test was four (4) points, with a cumulative time of 1416 seconds.

Qualitative Analysis of the Two Subtests from the Zareki-R-A Battery in Its Algerian Version:

When applying the test to case M.N., it was observed that the case demonstrated weaknesses in the Verbal Mental Arithmetic Test, showing clear hesitation in providing answers and taking an extended time to respond. Despite attempting to use fingers for calculation, the case showed deficiencies in managing mental arithmetic, especially in subtraction operations. The case struggled to find methods for determining differences, taking longer than appropriate for the nature of the arithmetic problems presented.

Regarding the Verbal Arithmetic Problems Test, case M.N. showed significant difficulties in correctly solving arithmetic problems. The scores ranged from one point in problems 1, 2, 3, and 5 to zero points for problems 4 and 6, with times ranging between 220 and 240 seconds. The case exhibited substantial difficulty in finding methods to solve the problems, took a long time to reach solutions, and showed hesitation in providing answers. This indicates that the case suffers from a disturbance in numerical ability and difficulty in accurately representing problems.

-Quantitative Analysis for Case 2 (S.R.)

Mental Arithmetic Test:

The case of S.R. showed hesitation in providing answers, scoring one point in the first problem, zero points in the second and third problems, two points in the fourth and fifth problems, and one point in the sixth problem. This results in a total of six (6) points out of 12, with an average completion time of 140 seconds.

S.R. scored 12 points in addition problems with a completion time of 84 seconds, 8 points in subtraction problems with a longer completion time of 189 seconds, and 12 points in multiplication problems with a shorter completion time of 18 seconds.

-Verbal Arithmetic Problems Test:

The case showed moderate to weak results, scoring zero (0) points in the third and fifth problems despite the extended time taken, which ranged between 240 and 293 seconds respectively. S.R. scored one (1) point in the second, fourth, and sixth problems with completion times of 198, 240, and 240 seconds respectively, and two (2) points in the first problem with a completion time of only 60 seconds. The total score for the test was five (5) points, with a total completion time of 1206 seconds.

-Qualitative Analysis of the Sub-tests from the Zareki R-A Battery in its Algerian Version:

When applying the test to S.R., it was evident that there was a weakness in the results of the Mental Arithmetic Test. S.R. showed a tendency to rush in providing answers without verifying their accuracy and demonstrated difficulty particularly in subtraction problems. Additionally, S.R. exhibited anxious behavior during the test, took longer to complete the tasks, and repeatedly asked for clarifications, indicating a significant struggle with mathematical processing.

In the Verbal Arithmetic Problems Test, it became clear that S.R. has a deficiency in solving arithmetic problems, especially in devising logical strategies to approach the problems. This was evident in most of the problems, as well as the longer time taken to complete the tasks, which ranged between 175 and 293 seconds. S.R. also displayed hesitation when providing final answers, further confirming the difficulties in mathematical processing for problem-solving tasks.

-Quantitative Analysis for Case 3 (A.F.)

Mental Arithmetic Test:

After administering the test, A.F. displayed a weak performance, scoring zero (0) points in problems (3), (4), and (6), and one (1) point each in problems (1), (2), and (5). A.F. showed weak results in addition, subtraction, and multiplication operations with completion times ranging between 210, 145, and 80 seconds respectively. The total score for the six problems was three (3) points out of 12, and the total score for the three types of operations was 16 points with a total completion time of 435 seconds for all three operations.

-Verbal Arithmetic Problems Test:

A.F. demonstrated moderate to weak results, scoring zero (0) points in the fifth and sixth problems, one (1) point each in the second, third, and fourth problems, and two (2) points in the first problem. The completion times ranged from 75 seconds for the first problem to 120 seconds for the second and fourth problems, 150 seconds for the third problem, and 240 seconds for the fifth and sixth problems. The total score for the test was five (5) points with a total completion time of 945 seconds.

-Qualitative Analysis of the Sub-tests from the Zareki R-A Battery in its Algerian Version:

The case of A.F. showed a clear weakness in the results of the Mental Arithmetic Test, indicating difficulties in performing arithmetic operations, including addition, subtraction, and multiplication. This contrasts with the first two cases, which showed better results in multiplication due to reliance on memorizing the multiplication table.

A.F.'s results indicate a significant deficiency in the mental processing of mathematical problems, evident in the inability to find solutions to arithmetic problems as reflected in the results of the Verbal Arithmetic Problems Test. Additionally, A.F. took a long time to complete the problems, totaling 945 seconds.

-Quantitative Analysis for Case 4 (D.S.)

Mental Arithmetic Test:

In the mental arithmetic test, D.S. scored one (1) point in problems (1), (3), (4), and (5), and zero (0) points in problems (2) and (6), resulting in a total score of four (4) points out of 12. The time taken to complete the test was significantly long, totaling 378 seconds. In the individual operations, D.S. scored seven (7) points in addition, five (5) points in subtraction, and eight (8) points in multiplication, with a total completion time for all operations of 586 seconds.

-Verbal Arithmetic Problems Test:

D.S. showed moderate results in the verbal arithmetic problems test, scoring zero (0) points in the sixth problem, one (1) point each in problems (2), (3), and (4), and two (2) points in the first problem. The completion times ranged between 80 and 240 seconds. The total score for the test was six (6) points, with a total completion time of 1258 seconds for all problems.

-Qualitative Analysis of the Results for Case 4: D.S. from the Zareki R-A Battery in its Algerian Version:

Upon administering the test to D.S., it was observed that D.S. exhibited a weakness in the mental arithmetic test results, taking a very long time to complete the operations and showing hesitation in providing final answers. D.S. faced difficulties in performing arithmetic operations and managing time, especially in subtraction operations.

In the verbal arithmetic problems test, the results indicated that D.S. struggled with processing arithmetic problems, had difficulty devising a plan to solve the problems, and took an exceptionally long time to provide answers while exhibiting hesitation in delivering results.

6-2- Presentation and Analysis of Figure de Rey Planning Test Results:

Table 5: Raw Results from the Figure de Rey Planning Test

Phase / Dimensions	**Presence of Parts**	**Accuracy**	**Positioning**	**Total Score**	**Total Points**	**Time Spent (seconds)**	**Type of Output**
Copy Phase	3.5	0	7	32	10.5	303	Mixed Details
Memory Reconstruction Phase	0.5	0	1	10	1.5	245	Scribble

Table 6: Results for Case 1 (M.N.):

Phase / Dimensions	**Presence of Parts**	**Accuracy**	**Positioning**	**Total Score**	**Total Points**	**Time Spent (seconds)**	**Type of Output**
Copy Phase	3.5	0	7	32	10.5	303	Mixed Details
Memory Reconstruction Phase	0.5	0	1	10	1.5	245	Scribble

Analysis:
In the copying phase, Case M.N. scored 27.5 points, taking a total of 660 seconds to replicate and color the drawing using the sequence of colors (green/red/yellow/green/blue/red/brown/yellow/brown/blue/green). The case began by replicating the general outline before moving to details and connected geometric shapes, revisiting the drawing repeatedly.
In the memory reconstruction phase, difficulty was observed in replicating the shape with randomness in copying parts, moving from one detail to another without completing the previous one, indicating a lack of clear, organized planning in the replication process, which is indicative of planning skill disorder.

Table 7: Results for Case 2 (S.R.):

Phase / Dimensions	**Presence of Parts**	**Accuracy**	**Positioning**	**Total Score**	**Total Points**	**Time Spent (seconds)**	**Type of Output**
Copy Phase	6	1.5	16	14	23.5	454	General Outline
Memory Reconstruction Phase	4	1.5	10	11	15.5	205	General Outline

Analysis:
During the copying phase, S.R. scored 23.5 points and took 454 seconds to copy and color the shape using a pen. S.R. used all the colors, starting with the general outline before moving to the detailed shapes. S.R. displayed difficulty in replicating the design with a lack of a consistent reproduction strategy; S.R. would draw one part, move to another without completing the first, and then return to the unfinished part.

An inconsistency in the coloring process was also observed; S.R. would use one color and then change it, indicating hesitation and the absence of a plan for reproducing the geometric shape of Rey. This behavior suggests a disorder in the planning skills necessary for task execution.

Table 8: Results for Case 3 (A.F.):

Phase / Dimensions	Presence of Parts	Accuracy	Positioning	Total Score	Total Points	Time Spent (seconds)	Type of Output
Copy Phase	3.5	0	7	32	10.5	303	Mixed Details
Memory Reconstruction Phase	0.5	0	1	10	1.5	245	Scribble

Analysis:
During the copy phase, A.F. demonstrated a fragmented copying process for the Rey shape, where each part was reproduced separately from the others. A.F. neglected many parts and details, indicating either a weakness in planning or a complete absence of a structural planning framework. This also led to a total lack of precision.
During the reproduction phase, the output resembled scribbling, which suggests a disruption in planning skills needed to mentally reconstruct the shape and project it onto the drawing. This behavior reflects significant difficulties in organizing and structuring the reproduction process mentally before executing it on paper.

Table 9: Results for Case 4 (D.S.):

Phase / Dimensions	Presence of Parts	Accuracy	Positioning	Total Score	Total Points	Time Spent (seconds)	Type of Output
Copy Phase	3.5	0	7	32	10.5	303	Mixed Details
Memory Reconstruction Phase	0.5	0	1	10	1.5	245	Scribble

Analysis:
The case showed weakness in completing the copying task in terms of precision, as many details were overlooked. During the reproduction phase, the case displayed a deficiency in restructuring the image, noting random, slanted lines within and outside of the rectangle. This indicates a disruption in planning skills, characterized by an inability to systematically reconstruct and organize the image during the reproduction process.

7-. Discussion:

Based on the outcomes derived from the participants who underwent the Zareki-R-A dyscalculia test and the Rey-Osterrieth Complex Figure test (ROCFT), and taking into account the insights from prior theoretical and empirical studies, the hypothesis of the current research was substantiated. This hypothesis posits the presence of a planning strategy disorder among third-grade primary students diagnosed with dyscalculia.
This was observed through a noticeable disruption in planning skills across all dyscalculia cases, alongside behaviors indicative of hesitation and concentration difficulties. These issues were particularly pronounced during the second phase of the ROCFT. The difficulties became conspicuous when the participants were tasked with solving verbally presented mathematical problems, which form the second subtest of the Zareki battery.
The participants displayed a marked struggle with planning and devising strategies to tackle especially complex mathematical problems. This finding resonates with the conclusions of Gaux et al. (2007), which highlighted the pivotal role that planning strategies play in solving logically and mathematically oriented problems among students, as well as the findings by Goswami (2002), which pointed to a deficit in planning skills among primary students with dyscalculia.
Furthermore, the outcomes of this study align with those of Chung et al. (2014), which suggested that a well-formulated planning strategy provides a predictive framework for determining whether a student is likely to face challenges in mathematical reasoning. The same study demonstrated that poor mastery over planning skills is reflected in subpar

mathematical performance, a conclusion also supported by the research conducted by Masseau and Pouchet (2014). Their research established a significant correlation between the level of mathematical performance and the proficiency in planning skills, as evidenced by the results following the administration of the complex ROCFT.

Additionally, the findings of this investigation are consistent with the study by Hooper and Williams (2005), which identified a correlation between planning abilities and mathematical skills following the application of the complex ROCFT on a sample of primary students with dyscalculia. This connection was further corroborated by Vanden Heuvel (2005), who concluded that there is a noticeable decline in mathematical proficiency among students exhibiting weaknesses or deficiencies in planning skills.

Drawing from the corpus of existing research and studies, it can be affirmed that they collectively validate the findings of the current applied study. This research potentially paves the way for a deeper exploration of these variables on a broader sample, aiming to assist this group of students in surmounting the challenges they encounter in mathematics.

8-Conclusion:

The findings from this study are significantly illuminating, underscoring the pivotal role of executive functions in enhancing mathematical and logical reasoning, particularly the planning function in third-grade students diagnosed with dyscalculia. It is evident that mathematical achievement is intricately connected to a student's executive capabilities, notably planning strategies.

Impairments in this area lead to deficient mental processing of mathematical problems, along with challenges in managing the time required to resolve these problems (extended problem-solving durations) and reluctance in responding due to disruptions in the planning processes in students with dyscalculia.

The insights garnered from this research can substantially benefit educational practitioners and specialists in dyscalculia by integrating these findings into early diagnostic approaches. Given that the planning function acts as a predictive indicator for dyscalculia, the study can facilitate timely interventions tailored to support affected students.

9-Recommendations:

Prioritize attention to students with learning difficulties through proactive identification and early intervention to enhance the efficacy of outcomes.

Establish interdisciplinary teams within Algerian schools dedicated to the comprehensive support of this demographic.

Develop and implement therapeutic protocols designed to rehabilitate the executive functions of students with dyscalculia and broader learning challenges.

Promote awareness within educational circles and the broader community about learning difficulties, particularly dyscalculia. This initiative aims to inform parents and educators about the severity of these conditions and the critical need for early and effective intervention to mitigate the adverse impacts on students' educational trajectories.

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