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The Cognitive Profiles Of Students With Low Academic Achievement In Mathematics- Cases From Primary School In Algeria

Chergui Houria[1], Maamir Narimen[2], Saadat Fadhila[3]

[1,2,3]School and its Environment Research Division, National Institute for Research in Education (Algeria), E-mail: houria.chergui@inre.dz[1], narimen.maamir@inre.dz[2], fadhila.saadat@inre.dz[3]
ORCID iD Link: 0000-0001-5287-236x[1]; 0000-0002-3113-8948x[2]; 0000-0003-2740-186x[3]
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Abstract:

The results of low academic achievement in mathematics are related to many factors, including the cognitive aspect of the students, so the current study aims to investigate the cognitive profile of students with low academic achievement in mathematics, and to reach the purpose of the study, three areas of cognitive processes associated with low achievement in mathematics were researched: working memory(WM), processing speed(PS) and Perceptual Reasoning (PR), using the Wechsler Intelligence Test for Children IV. By following the descriptive approach, the subtests of this test were applied, namely: The number memory test, the letter-number sequence test, the arithmetic test for the working memory index, as for the subtests of deletion, coding and symbol search for the processing speed index, and the tests for the Perceptual Reasoning index represented by its tests in cubes, matrices and image repetition on a sample of students selected by random method from primary schools from the western side of Algiers, which amounted to (36) male and female students, where the results of the study resulted in the following:

students are characterized by a very weak level of working memory, processing speed and cognitive demonstration, as the poor performance of these indicators was associated with the low level of academic achievement in the sample of students under study, and thus the results showed three weak cognitive features characterized by low-achieving students in mathematics.

Keywords: Cognitive profile; math achievement; working memory; processing speed; Perceptual Reasoning.

Introduction:

The cognitive aspect of a child's personality is a very important topic for educators. Especially in the transition from childhood to early childhood; wich is a stage of learning and acquiring knowledge. A child's school achievement requires the availability of factors such as the ability to deal with abstract conceptual problems, speed of processing, and his ability to pay attention and cognition. As a result, researchers began to explore the effects of cognitive personality traits on many different variables, including achievement in mathematics because of its importance in determining a child's professional future (Abbas , Malahat , & et all, 2019).

As a result , researchers are beginning to explore the effects of different cognitive on many different variables, including mathematics achievement ,being there is greater need for individuals who are skilled in math. Math skills are relevant for many career fields in the future (Nayana Blankson & et al, 2016)

An increasing number of studies have found that human abilities consist of many different components that are interrelated, but that would be expected to have unique effects on a given outcome, such as math achievement. Therefore, it has been argued that increased attention should be paid to examination of specific cognitive abilities to increase our understanding of the factors that predict achievement (Nayana Blankson & et al, 2016)

Therefore, attention should be paid to examination of specific cognitive abilities to

increase our understanding of the factors that predict achievement, where A growing number of studies focus on distinct cognitive constructs, primarily fluid intelligence, crystallized intelligence, and executive functioning, in the examination of achievement academic outcomes (Lina , Morena , & Et all, 2022)

Based on clinical point of view, typically cognitive functioning assessed through a standardized and comprehensive intelligence test that is composed of subtests; which assess specific cognitive functioning domains and enable a general intelligence score to be computed. The "verbal index", which assesses the ability to access and apply acquired word knowledge and the capacity for reasoning that involves words; and the "non-verbal (or performance) index", which assesses the ability to understand and apply visual-spatial information and the capacity for visual-spatial reasoning are the more widely used. In recent years, other indices have been proposed that describe other aspects of intelligence, such as working memory or processing speed. (Alan , Kufman, & Et al, 2006)

The analysis of the WISC-IV cognitive profiles of gifted children revealed that these children's greatest cognitive strengths were in the verbal reasoning, visual perception, and fluid reasoning. In contrast, working memory ability and speed of cognitive processing, despite being typically higher than the general population average, were found to be a "weak" point in the profile of the gifted (Lina , Morena , & Et all, 2022)

A growing body of literature has revised the AC-ID profile by adding the general knowledge subtest to the attention distraction index developed by Kaufman (arithmetic, coding, number series) Their research showed that children with SLDs scored lower in these subtests because of their weakness in short-term and long-term memory, visual-spatial coordination, and mathematical processing skills (Mevlut Cirik, Ugur, Deniz, & ET ALL, 2023) From this standpoint, the present paper seeks to reveal the cognitive profile of children with low academic achievement in mathematics, based on The Wechsler Intelligence Scale for Children.

Therefore, the study question :What is the cognitive profile of low achieving students in mathematics?

Methods:

The current study, conducted descriptive method to diagnose the difficulties experienced by students with low academic achievement in mathematics based on the performance subtests of the Wechsler Intelligence Test, fourth edition.

Participants:

Participants for the study sample were randomly selected from primary schools in the western part of Algiers. The sample consisted of 36 male and female students aged between 8 years and 11 years, 11 months and 15 days. Their average academic achievement in maths was less than 5 points, as measured by the Children's Intelligence Scale , 4th edition. In this group of students, parental consent was obtained prior to the start of the study.

Instrument:

For the purpose of collecting results from the field, it was applied Wechsler Intelligence Scale for Children- Fourth Edition (WISC-IV) Below is a presentation of it:

The Wechsler Intelligence Scale for Children (WISC) is the most frequently used test to assess intellectual functioning and academic potential in children and adolescents The WISC is used by clinical and educational psychologists as well as neuropsychologists to provide deeper insights into how a child learns and to identify cognitive patterns. Along with a measure of general intellectual functioning (Full Scale IQ, FSIQ), the fourth edition of WISC-IV has a four-factor structure to represent more narrow domains of cognitive functioning Verbal Comprehension Index (VCI), Perceptual Reasoning Index (PRI), Processing Speed Index (PSI) (Maria & et all, 2023)

They are as follows:

1.Verbal Comprehension (VCI)

In this study, we relied on the rest of the following indicators:

2. Perceptual Reasoning) (PRI)

3. Working Memory (WMI)

4.Processing Speed (PSI)

Subtests are as follows:

VCI subtests
1. Similarities
2. Vocabulary
3. Comprehension
4. Information
5. Word Reasoning

PRI subtests
1. Block Design
2. Picture Concepts
3. Matrix Reasoning
4. Picture Completion

WMI subtests
1. Digit Span
2. Letter-Number Sequencing
3. Arithmetic

PSI subtests
1. Coding
2. Symbol Search
3. Cancellation

Verbal
1. Information
2. Smilarities
3. Arithmetic
4. Vocabulary
5. Comprehension
6. Digit Span

Performance
1. Picture Completion
2. Coding
3. Picture Arrangement
4. Block Design
5. Object Assembly
6. Symbol Search
7. Mazes

(Fatih & Recep , 2012, p. 2108)

Tool properties

A/ Honesty: Internal consistency was assessed by estimating the Pearson correlation coefficient between the results of each indicator of the Wechsler test and its total score. The results were as follows: (Perceptual Reasoning index, the correlation value was estimated at (0.71), working memory index: The correlation value was estimated to be (0.67). Processing speed index: The correlation value was estimated to be (0.49). These findings are robust, with statistically significant values, indicating a high degree of consistency in the observed results..

B/ Reliability: The reliability of the application and re-application method was assumed, with the reliability coefficient estimated by calculating the Pearson correlation coefficient between the results of the first application and the second application for each indicator of the Wechsler test. The results were as follows: (Perceptual Reasoning index (0.84)), working memory index (0.77), processing speed index (0.74)). It is evident that the values were elevated and statistically significant, which signifies that this test exhibits stability in its outcomes between the two applications (Romanah, 2017, p. 278).

Results:

In order to respond to the overarching question, this is as follows: The cognitive profile of low-achieving students in mathematics was investigated. The Wechsler scale of intelligence for children was employed, with subtests applied to assess working memory, processing speed, and Perceptual Reasoning. The results are presented below.

1- The working memory index (WMI)for the study sample.

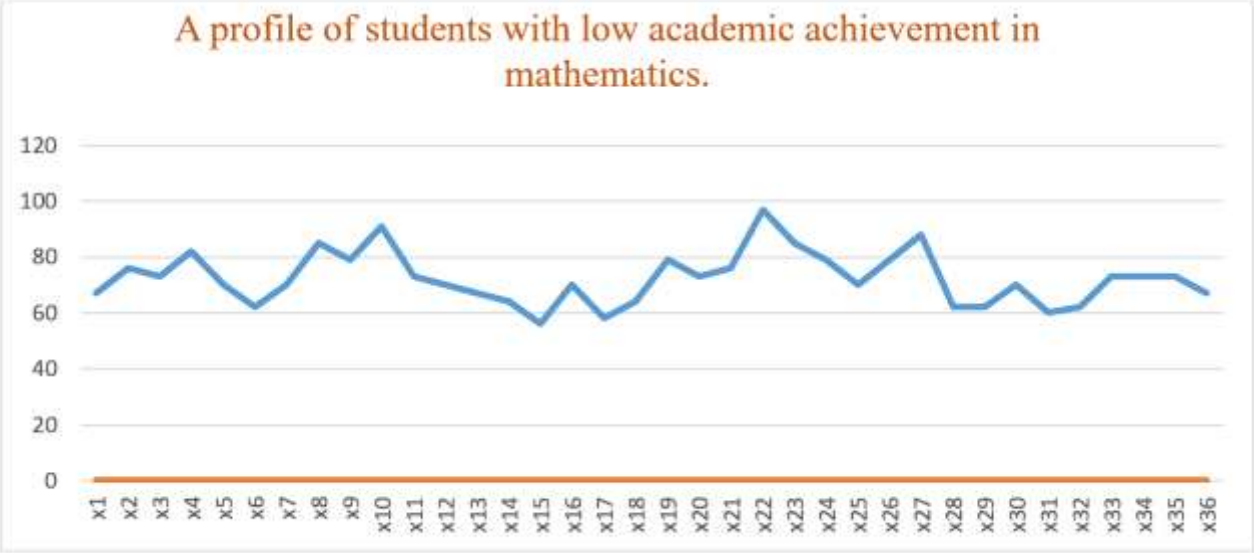
The scores of the students in the study sample were collected in the sub-tests of the working memory index (Digit Span, Letter-Number Sequencing, Arithmetic). The standard score was then calculated, and the weighted scores were extracted and are shown in the graph and table below:

Table No. (1): The chart illustrates the standard and weighted scores for the working memory index among the study sample

The case	chronological age	total standardised score of the Working Memory Index	the weighted score of the Working Memory Index are presented in this section	Description level
x1	9years , 11 months and 7 days	9	67	Very weak
x2	8years , 4 months and 27 days	12	76	Limits of marginality
x3	9years , 1 month and 4 days	11	73	Limits of marginality
x4	8years , 6 months and 29 days	14	82	Weak average
x5	8years , 11 months and 8 days	10	70	Limits of marginality
x6	9years , 2 months and 15 days	7	62	Very weak
x7	8years , 3 months and 29 days	10	70	Limits of marginality
x8	8years, 2 months and 28 days	15	85	Poor average
x9	years, 4 9 months and 14 days	13	79	Limits of marginality
x10	10years, 2 months and 1 day	17	91	middle
x11	8years , 9 months and 4 days	11	73	Limits of marginality
x12	9years and 1 day	10	70	Limits of marginality
x13	9years, 7 months and 16 days	9	67	Very weak
x14	11years, 11 months and 15 days	8	64	Very weak
x15	9years, 2 months and 4 days	4	56	Very weak
x16	10years, 8 months and 8 days	10	70	Limits of marginality
x17	10years 8 months and 3 days	5	58	Very weak
x18	10years 2 months	8	64	Very weak
x19	10years 8 months 9 days	13	79	Limits of marginality

x20	10years , 01 months and 21 days	11	73	Limits of marginality
x21	11years, 10 months, 20 days	12	76	Limits of marginality
x22	8years 2 months and 16 days	19	97	middle
x23	8years and 8 days	15	85	average weak
x24	8years , 3 months and 19 days	13	79	Limits of marginality
x25	8years , 8 months and 21 days	10	70	Limits of marginality
x26	9years , 6 months and 17 days	13	79	Limits of marginality
x27	8years , 9 months and 8 days	16	88	average weak
x28	9years , 6 months and 11 days	7	62	Very weak
x29	10years , 1 month and 23 days	7	62	Very weak
x30	9years , 3 months and 17 days	10	70	Limits of marginality
x31	9years , 8 months and 14 days	6	60	Very weak
x32	10years and 1 day	7	62	Very weak
x33	9years , 1 month and 29 days	11	73	Limits of marginality
x34	9years, 7 months and 22 days	11	73	Limits of marginality
x35	8years , 11 months and 13 days	11	73	Limits of marginality
x36	9years , 6 months and 6 days	9	67	Very weak -

The following graph illustrates the working memory profile of students with low academic achievement in mathematics



The data presented in Table No. (01) clearly indicates that: The results of the sub-tests of the working memory index among the students in the study sample indicate a discrepancy in level, with the majority of students exhibiting marginal to very weak working memory performance. Specifically, 18 students obtained a level of marginal limits, while 5 students obtained an average grade and a weak average in their performance. The remaining students received a weak grade in the same indicator. This level was determined by analysing the data provided by the students, calculating the standard score and the weighted score to extract their level of characterisation and thus ascertain the nature of the characteristic.

2- The processing speed index (PSI) of the study sample:

The study sample's answer scores on the subtests of the processing speed index (Coding, Symbol Search, Cancellation) were collected and converted into standard scores and weighted scores.

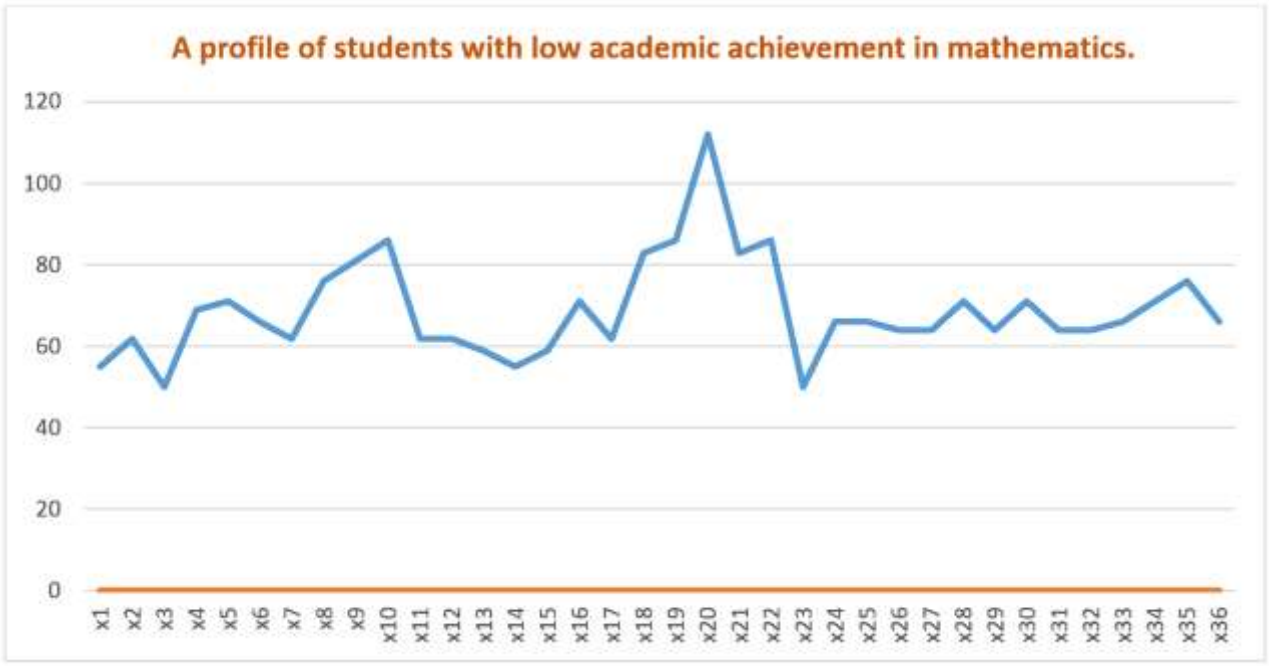
Table No. (2): shows the standard score and weighted score for the PSI for the study sample

The case	chronological age	total standardised score of the processing speed Index	the weighted score of the processing speed Index	Description level
x1	9years , 11 months and 7 days	3	55	Very weak
x2	8years , 4 months and 27 days	5	62	Very weak
x3	9years , 1 month and 4 days	2	50	Very weak
x4	8years , 6 months and 29 days	8	69	Very weak
x5	8years , 11 months and 8 days	9	71	Limits of marginality

x6	9years , 2 months and 15 days	7	66	Very weak
x7	8years , 3 months and 29 days	5	62	Very weak
x8	8years, 2 months and 28 days	11	76	Limits of marginality
x9	years, 4 months 9 and 14 days	13	81	average weak
x10	10years, 2 months and 1 day	15	86	average weak
x11	8years , 9 months and 4 days	5	62	Very weak
x12	9years and 1 day	5	62	Very weak
x13	9years, 7 months and 16 days	4	59	Very weak
x14	11years, 11 months and 15 days	3	55	Very weak
x15	9years, 2 months and 4 days	4	59	Very weak
x16	10years, 8 months and 8 days	9	71	Limits of marginality
x17	10years 8 months and 3 days	5	62	Very weak
x18	10years 2 months	14	83	average weak
x19	10years 8 months days 9	15	86	average weak
x20	10years , 01 months and 21 days	24	112	above average
x21	11years, 10 months, 20 days	14	83	average weak
x22	8years 2 months and 16 days	15	86	average weak
x23	8years and 8 days	2	50	Very weak
x24	8years , 3 months and 19 days	7	66	Very weak

x25	8years , 8 months and 21 days	7	66	Very weak
x26	9years , 6 months and 17 days	6	64	Very weak
x27	8years , 9 months and 8 days	6	64	Very weak
x28	9years , 6 months and 11 days	9	71	Limits of marginality
x29	10years , 1 month and 23 days	6	64	Very weak
x30	9years , 3 months and 17 days	9	71	Limits of marginality
x31	9years , 8 months and 14 days	6	64	Very weak
x32	10years and 1 day	6	64	Very weak
x33	9years , 1 month and 29 days	7	66	Very weak
x34	9years, 7 months and 22 days	9	71	Limits of marginality
x35	8years , 11 months and 13 days	11	76	Limits of marginality
x36	9years , 6 months and 6 days	7	66	Very weak

The following graph illustrates the processing speed profile of students with low academic achievement in mathematics



The results of the cases studied and shown in Table No. (02) indicate that 22 students obtained a very weak level of description, while the number of students who obtained a marginal level reached 5 students, while the rest of the students obtained an average to above average level. This indicator was obtained through the sub-tests represented in the Coding, Symbol Search, Cancellation test, which reflects the weak performance in the processing speed index. Consequently, the academic achievement in mathematics among the students was low.

3- Perceptual Reasoning index(PRI) among the study sample:

The students' scores on the subtests of the PRI were collected, standardized scores were created, and then converted to weighted scores, which are shown in the graph and table below:

Table No. (3): shows the standard score and weighted score for the PRI among the study sample.

The case	chronological age	total standardised score of the Perceptual Reasoning Index	he weighted score of the Perceptual Reasoning Index	Description level
x1	9years , 11 months and 7 days	11	61	Very weak
x2	8years , 4 months and 27 days	20	79	Limits of marginality
x3	9years , 1 month and 4 days	14	67	Very weak
x4	8years , 6 months and 29 days	13	65	Very weak

x5	8years , 11 months and 8 days	12	63	Very weak
x6	9years , 2 months and 15 days	7	54	Very weak
x7	8years , 3 months and 29 days	13	65	Very weak
x8	8years, 2 months and 28 days	14	67	Very weak
x9	years, 4 9 months and 14 days	12	63	Very weak
x10	10years, 2 months and 1 day	12	63	Very weak
x11	8years , 9 months and 4 days	17	73	Limits of marginality
x12	9years and 1 day	11	61	Very weak
x13	9years, 7 months and 16 days	12	63	Very weak
x14	11years, 11 months and 15 days	5	50	Very weak
x15	9years, 2 months and 4 days	7	54	Very weak
x16	10years, 8 months and 8 days	8	56	Very weak
x17	10years 8 months and 3 days	5	50	Very weak
x18	10years 2 months	17	73	border Marginal
x19	10years 8 months 9 days	9	58	Very weak
x20	10years , 01 months and 21 days	10	60	Very weak
x21	11years, 10 months, 20 days	6	52	Very weak

x22	8years 2 months and 16 days	28	94	middle
x23	8years and 8 days	15	69	middle
x24	8years , 3 months and 19 days	17	73	Limits of marginality
x25	8years , 8 months and 21 days	17	73	Limits of marginality
x26	9years , 6 months and 17 days	17	73	Limits of marginality
x27	8years , 9 months and 8 days	19	77	Limits of marginality
x28	9years , 6 months and 11 days	7	54	Very weak
x29	10years , 1 month and 23 days	6	52	Very weak
x30	9years , 3 months and 17 days	16	71	Limits of marginality
x31	9years , 8 months and 14 days	12	63	Very weak
x32	10years and 1 day	9	58	Very weak
x33	9years , 1 month and 29 days	8	56	Very weak
x34	9years, 7 months and 22 days	7	54	Very weak
x35	8years , 11 months and 13 days	18	75	Limits of marginality
x36	9years , 6 months and 6 days	18	75	Limits of marginality

A graph illustrating the cognitive profile of students with low academic achievement in mathematics.

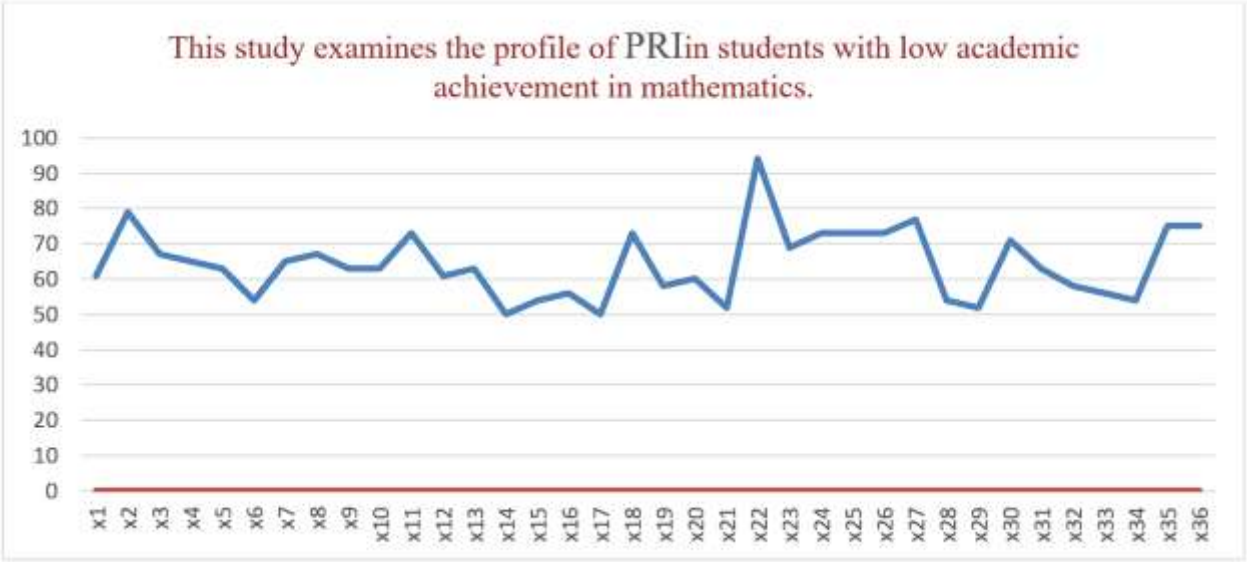


Table No. (03) demonstrates that the majority of students ' results in the PRI are below average. Some students achieved marginal to average results in the Block Design , Matrix Reasoning ,Picture Completion test, which reflects the students' low academic achievement at this stage of education. The primary school level is of particular importance in this context, as it indicates the significant contribution of this indicator in influencing students' results.

Discussion:

The objective of this study was to investigate the cognitive profile of low-achieving students in mathematics in a sample of primary school from the western part of Algiers. To this end, three areas of cognitive processes associated with low achievement in mathematics were investigated: Working Memory, Processing Speed and Perceptual Reasoning index The weak performance of these indicators was associated with low academic achievement in the sample of students in the study, which was measured by determining the chronological age of each student with a series of analyses. These included calculating the standard score and weighted scores of the WMI, the PSI, and the PRI. The digit span, letter-number sequence, arithmetic, and the subtests of cancellation, coding, and symbol search were applied in the PSI, while the subtests of block design, matrix reasoning, and picture completion were applied in the PRI. After collecting and tabulating the data, the results obtained in Tables (01), (02), and (03) mentioned earlier were obtained.

Therefore, students with low academic performance in mathematics are characterised by their inability to store and reprocess information, This was demonstrated by the study of Garcia-Madruga et al. (2014), which found that working memory can predict changes in academic achievement, Additionally, the study of Baker et al. (2014) through their observations of inhibitory and working memory functions were only associated with academic achievement, as was the study of Abbas, which proved that "processing speed", "organisational cognition", "monitoring", "planning" were significantly associated with academic performance. The results demonstrated that the cognitive profiles of the participants were significantly associated with their academic performance. This indicates that there is a statistically significant relationship between cognitive profile and academic performance (Abbas, Malahat, & et all, 2019, p. 169).

The results of Mevlut Cirik's study suggest that impaired sequential processing memory may contribute to learning disabilities (Mevlut Cirik, Ugur, Deniz, & ET ALL, 2023, p. 72).

In contrast, Sobh's (2017) study found that the level of working memory in blind and sighted individuals is high. This finding is contrary to the results of the aforementioned study.

Many studies have shown the relationship between working memory and academic

achievement such as reading and writing, including the study of Sreej and Lozai (2022), whose results showed that there is a relationship between the executive processing system of working memory and reading comprehension, and The study by Boufatah and Ben Issa (2016) demonstrated a correlation between reading comprehension and working memory in primary school students. Additionally, Wahib (2017) indicated a relationship between working memory and listening skills in English.

Conversely, it is notable that the subtests employed in this study necessitate focused attention and concentration, particularly in the number repetition test with the two tasks of forward and reverse ordering. While both of these tasks require the recording of auditory information, the reverse number repetition task is associated with greater demands on mental processing abilities (working memory) than the forward number repetition task. This may explain why the majority of cases are within the marginal range of working memory performance, between weak and average levels.

A weak performance on this subtest is indicative of a limited capacity for auditory information. This may be attributed to difficulties in maintaining attention during auditory processing, difficulties in auditory discrimination, or other significant issues (Al-Beheri A, 2017, p. 173).

The letter-number sequence subtest necessitates the engagement of attention, visual-spatial representation, and short-term auditory memory to facilitate the representation of the associative sequence between letters and numbers that the child hears. This requires the child to repeat them in ascending order (Al-Beheri A., 2017, page 49).

With regard to the PSI, the results demonstrated that the students in the study sample exhibited a similarly weak level of performance. The PSI subtest provides a measure of the child's ability to scan, sequence, or recognise simple visual information quickly and correctly. The composite scale also measures short-term visual memory, attention, visual perception, and visual-motor synergy. It is crucial to acknowledge that the subtests comprising the Processing Speed Scale are not indicative of simple reaction time or simple visual discrimination. Instead, they encompass decision-making or learning tasks, which are profoundly influenced by attention disorders and learning disabilities (El-Beheiry, 2017, p. 177).

The results of the study by Gibson, Healey, and Gondoli (2019) demonstrate that individuals with Attention Deficit Hyperactivity Disorder (ADHD) exhibit impaired encoding and retrieval processes. The study employed a working memory task, namely verbal presentation tasks, which required the participants to retrieve what they had heard. The results revealed that the ADHD group exhibited significantly lower performance in the encoding and retrieval processes compared to the control group. (Jadid and Mansour, 2005, pp. 135-136)

The results of our study were in contrast to those of Al-Beheiry (2017), who found that children with ADHD exhibited normal cognitive function, with high performance on the processing speed index (Al-Beheiry, 2017, p. 150).

The results of the study also indicated that the PRI is relatively low. This index plays a significant role in enhancing the student’s concentration with the teacher, as well as their reading comprehension and ability to follow instructions in solving various problems, exercises, and activities within the department. This is consistent with the findings of Lina (2022), who examined the cognitive profile of gifted children. In this study, the IQ and cognitive abilities of a sample of gifted Italian children were evaluated using the Wechsler scale. Fifty-nine gifted children aged 6 to 14 years were given a test, the WISC IV, during their presence. The WISC IV was administered to the gifted children while they were present, with particularly high scores in verbal comprehension (VCI) and visual perceptual reasoning (Lina, Morena, & Et al., 2022).

The study (Rosenberg, 1989) examined the relationship between attention deficit hyperactivity disorder (ADHD), sensory-motor aspects and social compatibility (compatibility with friends) in children with mathematics learning difficulties. The results indicated a significant decrease in the scores of the first sample on both sensory-motor

perception and attention (relationships with friends) (Ziadeh, 2006, p. 141).

The results of the study indicate that students with low academic achievement in mathematics exhibit deficiencies in Working Memory, Processing Speed, and Perceptual Reasoning. This suggests that the cognitive profile of these students is characterised by weaknesses in numerous mental processes that are essential for learning, which in turn leads to low achievement in mathematics.

The objective of Al-Zayyat's (1986) study was to investigate the impact of repetition and the level of information processing on the memorisation and recall processes, as well as to ascertain the rate of recall (retrieval) in relation to varying levels of information processing. Additionally, the study sought to identify the factors that influence the rate of memorisation and recall. The researcher found that the manner in which a person processes the material and receives, processes and stores the information is of great importance in determining the subsequent recall of the information (Makhloufi, 2017, p. 290).

Mathematics is a scientific discipline that necessitates comprehension, analysis and memorisation. In order for a student to be able to solve various situations and operations in mathematics, they must possess a capacity for working memory. This is the ability to retain and organise information in a way that allows for easy retrieval, processing and execution. Furthermore, it often requires the ability to synthesise and interpret knowledge in a way that is aligned with the student's own frame of reference. This is known as cognitive abilities, which are an essential aspect of academic achievement

The results of the study indicate that the students in the study sample obtained low results in mathematics achievement due to weaknesses observed in various cognitive processes, namely Working Memory, Processing Speed and Perceptual Reasoning. This is supported by numerous studies, which have shown that these three indicators have a clear impact on the academic achievement of students. Therefore, any defect affecting these processes reduces the results of academic achievement in the subject of mathematics.

The study questions were answered through this study.

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