

Mathematical Problem-Solving Skills and Achievement among Students with Autism and its Relationship to the Arithmetic Test of the Wechsler-4 Scale

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Abstract

This study aimed to identify the mathematical problem-solving skills and achievement of (autism spectrum disorder, ASD) students and their relationship to the arithmetic test of the (Wechsler-4, WISC-4) scale through indications of the Validity and Reliability of the measures used to diagnose students with (ASD) for the age group (7-15) years. The sample of the study included (18) students with (ASD), and a scale was applied to each of the mathematical problem-solving skills (understanding the issue, developing a solution plan, implementing the solution, validating the solution) and sub-achievements (arithmetic) from the (WISC-4) scale on them.

Significances were reached for the content validity of the scales by (80%), and the skills of solving mathematical problems were tested. The value of the correlation coefficient of marks for the first dimension of understanding the issue was (0.887), developing a solution plan (0.774), implementing the solution (0.651), and verifying the validity of the solution (0.578), and achievement through the school's reliance on some skills and questions related to mathematics, some appropriate tests for students, and the mathematics test from the Wechsler scale -4 through arithmetic inference, which indicates the validity of the mathematics test from the scale.

Significances of Reliability were attained by using the Cronbach alpha test, where the value of the coefficients for the signs of (ASD) students on the four-dimensional mathematical problem-solving skills test was (0.677), as well as achievement, which amounted to (0.807), and the mathematics test from the (WISC-4) from by re-correcting the response registration forms for eighteen marks related to the arithmetic test, which reached the value of the (WISC-4) scale. In addition, for a sample of students with (ASD) (0.791), there was no statistically significant link between mathematical problem-solving ability, achievement, and arithmetic testing on the (WISC-4) scale. And the ineffectiveness of the components of mathematical problem-solving skills and achievement among (ASD) students in the (WISC-4) arithmetic test.

The study recommends conducting more studies and research related to (ASD) and its impact on mathematics.

Keywords: *Mathematical problems, Achievement, Wechsler-4 scale, Autism..*

Introduction

Autism is one category that carries with it a special significance that is difficult for the

individual to understand, due to the absence of a common language among some researchers and their inability to understand their

mathematical characteristics, so what if (ASD) is accompanied by some special abilities or talents? As a result, we are discussing a special education category with outstanding ability.

Autism attracts researchers from many scientific domains, including mathematics education, who use several study methodologies to investigate the topic. Autism research has been tackled with a variety of goals and methodologies, ranging from uncovering probable causes to ensuring the best outcomes for people who have been diagnosed.

Research Problem

Silence is evident in the autistic group, and some claim that it is deaf (cannot hear) and has unique communication methods that differ from other autistic groups, such as painting, utilizing particular symbols, and dealing with mathematical problems. The current study arose from this to provide us with a concept of the category of autism.

- What are the mathematical problem-solving skills and achievement of students with autism and its relation to the arithmetic test of the Wechsler-4 scale?

The following sub-questions arise from the research problem, which deals with the psychometric properties:

1- What are the indications of the Validity of mathematical problem-solving skills and achievement among autistic students, and its relationship to the arithmetic test of the Wechsler-4 scale?

2- What are the significances of Reliability, mathematical problem-solving skills and achievement among autistic students, and its relationship to the arithmetic test of Wechsler-4 scale?

3- What is the level of Mathematical problem-solving skills and achievement for autism students and its relationship to the arithmetic test of the Wechsler-4 scale?

4- What is the effectiveness of the paragraphs for Mathematical problem-solving skills and achievement among autistic students, and its

relationship to the Wechsler-4 scale arithmetic test?

Research Importance

First: The theoretical importance of this research lies in:

- Arousing interest in autism categories.
- Clarifying the relationship between mathematical ability and achievement for that category.
- According to the researcher, this is the first Arab study dealing with the study of people with autism using the mathematical capabilities of autism with outstanding talents.

Second: The practical importance:

- Recognizing the mathematical concept for people with autism.
- Enriching the field of autism to provide an understanding of this disability.
- Identifying the category, characteristics and mathematical features of the autism category.
- Helping researchers profit from the findings of this study in dealing with and talking with people who have autism, determining their mental and mathematical ability, and comprehending the occurrences that occur.
- Benefiting from the results of this study in making appropriate decisions in the diagnostic process.

Research Goals

Checking the category of autism with mathematical characteristics by reaching diagnostic criteria for that category.

Research Justification

- The scarcity of Arab studies that dealt with the search for mathematical steps in autism.
- The lack of Arab studies that focused on the Wechsler-4 scale through the subtest (arithmetic) for autism.

Research Limitations:

Research limits include the following:

- Age limits: The application of this study was limited to students with autism for the age group (7-15) years at the school stage.
- Spatial limits: The application of this study was limited to the Kingdom of Saudi Arabia (central, eastern region) through schools in which autism students were integrated.
- Temporal limits: Data for this study were collected during the academic year 2022.

Research Delimitations

The researcher was not able, through his research, to reach and identify other cases that have been integrated into schools in the Kingdom of Saudi Arabia.

Definitions of Terms

1- Mathematical problems: a problem facing the individual that needs a solution or a question that needs an answer, and in both cases the issue is a new and distinctive situation facing the individual.

2- Autism: It is a qualitative deficiency that appears in three developmental areas: social interaction, the ability to communicate (verbal and non-verbal), and a number of behavioral patterns, interests, and limited, repetitive, and stereotypical activities, which must appear before the age of three.

3- Achievement: It is the result that the student obtains through his studies in the previous years, i.e., the sum of the experiences and information that the student obtained.

4- Wechsler scale-4: the subject's score on the Wechsler intelligence scale for the sub-test (arithmetic).

Theoretical framework and Previous studies

Autism is defined by the American Autism Society (2014) as a disorder developmental disease that manifests itself during the first three years of life as a result of a neurological

disorder that impairs brain function. Individuals with these illnesses have impairments in speech, social interaction, and conduct. Autism is defined in neuroscience (connected to the nervous system) as having issues with brain development, particularly in language, social, and imaginative components (Linden Bridge School, 2014).

According to the (Centers for Disease Control, CDC), ASD is a collection of neurodevelopmental disorders characterized by social and communication difficulties as well as stereotypical repetitive behaviors. There have been numerous studies on the language deficit of hearing children with autism, where the most common characteristics of children with autism are (Echolalia), which is the unintentional repetition of other people's words, reversal of pronouns, the use of special language, and the creation of new words (Neologisms), difficulty with pragmatism (problems in interpreting the use of language in context and unfree use in language).

Autism, according to the (Autism Society of America, 2015) is a developmental disease that happens in youngsters who are exposed to closed-off environments. These illnesses cause children to have communication, social interaction, and behavioral impairments. According to this hypothesis, students with autism can be classified as having developmental impairments in communication and social interaction, as well as a lack of flexibility in thought and behavior. These traits correspond to the ASD diagnosis criteria.

Describes (Sussman, 1999) this through the learning process: Because it is simpler for children with autism to learn (understand educational content) through visual media, teachers have chosen to educate using methods that are visual media. Images, stickers, toys (balls and cubes), and other items may be used as tools. Whereas the mathematical learning process for students with autism can begin with the nature of concrete, by using drawings or tangible things around students, such as learning about geometry, and teachers can begin learning by presenting a form of geometry with a variety of concrete objects

such as cast iron and cardboard that have the same shape as a cubic shape. Students can be taught to recognize or categorize objects based on their similarities in personality, or they can be taught to do behaviors such as observing/seeing, experiencing, and detecting/recalling geometric shapes on actual objects being observed.

Many people (Carr et al., 2014) are still interested in differentiating between high and low-performing students. In the literature, criteria for identifying students with autism spectrum disorder as high or low functioning have been described.

First: Literature Review

First: Achievement for students with autism

According to (Hussar et al., 2020), recent research reveals that a subset of children with autism struggle with math achievement. And according to (Chen et al., 2018), samples of people with autism achieved poor achievement against low achievement.

Individual differences in social communication, IQ, and working memory, according to the studies reported by Mayes and Calhoun (2008), may be connected with differing patterns of academic accomplishment in individuals with autism. These observations on IQ have been conflicting. According to some studies, disparities in IQ may explain differences in math achievement. Other research has revealed data on groups of persons with autism who exhibit differences in their IQ and mathematical achievement, according to (Jones et al., 2009). According to Chiang and Lin (2007), academic attainment is an important area in which children with autism exhibit significant diversity.

According to (Baron-Cohen et al., 2007) the study of mathematical achievement in children with autism is an emerging topic of academic research; nonetheless, the results of primary studies exploring patterns of aptitude in mathematics have been inconsistent.

Many studies have found a subset of children with autism who have relative strengths in mathematical abilities that differ from the vast

majority of children who have the average arithmetic ability (Chiang, Lin, 2007; Howlin, Goode, Hutton, & Rutter, 2009; Wei et al., 2015). Recent research on autistic people has shown a high degree of variation in math skills, showing that inadequacies in this area may be more prominent than genius. A major gap in the literature is whether children with autism have a consistent pattern of strengths and deficits across several mathematics subtests, such as numeracy and problem-solving/reasoning, or whether variance in the ASD community presents itself in distinct subgroups. Affected youngsters consistently demonstrate athletic abilities.

A longitudinal study that similarly used this approach (Kim, Lord, 2017) found that the rate of fluctuation in measures of academic accomplishment ranged from 1% to 69%, depending on the affected groups' age, assessment, and general cognitive ability (i.e., IQ).

Second: Mathematics for students with autism

According to (Gevarter et al., 2016), the majority of successful research targeted at improving mathematical accuracy incorporated academic and academic components. Furthermore, they found that the bulk of the reintroductions were aimed at teaching basic math skills to participants with autism spectrum disorder (ASD) and related intellectual handicaps. According to reports, the majority of participants got the intervention in limited settings, such as one-on-one instruction or an autonomous classroom. Only a small amount of research has focused on high-performing individuals or more complicated mathematical skills, like word puzzles. It has been reported that research into more complicated talents is sparse.

And (Cline et al., 2014) examined the mathematics skills of children aged 7 to 12 years using cognitive evaluations and functional magnetic resonance imaging (MFRI). The answer to the single-digit addition problem has been investigated. Furthermore, the researchers re-used advanced analysis methodologies that are more effective in terms

of numbers. Despite the fact that disparities in athletic ability and performance have been found, (de Smedt et al., 2009) state that the basis of these variances is yet unknown. Many researchers (Bull & Scerif, 2001; Gathercole, Pickering, Knight, & Stegmann, 2004) link numerical performance to broader cognitive ability. Studies in the field of mathematical development disorders are also a significant source of information about cognitive processes that, when not working properly, lead to deficiencies in mathematical thinking.

Third: Wechsler scale-4 for students with autism

According to (Prifitera, Weiss, Rolfhus, Saklofske, 2005), the Wechsler Intelligence Scale, WISC-IV, is utilized in a variety of methods and for a range of objectives in research, clinical evaluations, and other types of evaluations and uses. Its power and capacity to deliver significant information were in a wide range of evaluations, including neuropsychological assessments, which were in their early stages when Wechsler began building his scales. He introduced the WISC-III system as a practical tool based on Dr. Edith Kaplan and her colleagues' assessment technique. The inclusion of the process method from the start is one of the Wechsler Scale-4's significant advances. This advancement broadens the domains of psychological processes measured by Wechsler and provides a helpful clinical tool, including a clinical and diagnostic sensitivity scale, as well as intervention strategies. Much of the research was conducted with clinical groups to aid clinicians in evaluating the results. WISC-IV has successfully integrated tasks that indicate ability on fluid intelligence, resulting in a more balanced instrument and the capacity to examine score variations between intelligence subtests as well as intelligence crystallization.

As (Bodin, Pardini, Burns & Stevens, 2009) indicate that the (Wechsler Intelligence Scale, WISC-IV, 2003) is a widely used scale that has excellent psychometric properties. The following four factorial structure was repeated (Verbal Comprehension Index, VCI), (Perceptual Reasoning Index, PRI), (Working

Memory Index, WMI), (Processing Speed Index, PSI) in different clinical samples, although it has also been indicated that it should not underestimate the effect of the level of general ability when interpreting the results of the worker index.

According to (McMullen, 2000), many findings on the mathematical abilities of autistic pupils may be found in the literature. Based on poor (WISC-4) test results for arithmetic subtests, some researchers described their mathematical abilities. According to (Griswold et al., 2002), students with autism have deficiencies in mathematics. Studies (Mayes, Calhoun, 2008) also suggested that individual differences in social communication, IQ, and working memory may be associated with distinct patterns of academic achievement in students with autism. As for IQ, these observations have been inconsistent. Some research suggests that differences in IQ may account for differences in math achievement.

Second: Previous studies

Conducted (Chen et al., 2019) a study entitled "Quantitative Analysis of Heterogeneity in Academic Achievement of Children with Autism" aimed at finding out the variation in cognitive abilities in mathematics among students with autism. The sample included (N = 114) children with ASD and (N = 96) matched controls. The results showed:

- Heterogeneity in (ASD).
- Decreased achievement of arithmetic skills.
- Verbal and central working memory skills were distinguished among these subgroups.

And (Bullen et al., 2022) conducted a study entitled "Patterns of Math and reading achievement in Children and Adolescents with autism spectrum disorder" aimed at assessing the validity implications of these previous studies and investigating the specific contribution of domain-general cognitive abilities to differences in these subgroups. The sample included (78) autistic people with an average age (M = 11.34). Mathematics and achievement measures, IQ, working memory,

deductive reasoning, and (Theory of Mind, ToM) were used. The results showed:

- The analysis revealed two unique achievement groups: one group that performed lower than expected in mathematics, and another group that performed higher than expected.
- The groups differed significantly in (IQ) and working memory and were distinguished by performance in reading fluency.
- The groups did not differ in the theory of mind, deductive reasoning, or symptomatology.

And (Polo-Blanco et al., 2022) conducted a study titled "Comparison of Mathematics Problem-Solving Abilities in Autistic and Non-autistic Children: The Influence of Cognitive Profile" to learn more about the connections between mathematical problem-solving performance (in terms of strategies used and accuracy) and key cognitive domains associated with mathematical learning (i.e., executive functions, verbal comprehension, and social cognition). The study comprised 26 autistic children and 26 non-autistic children without mental disorders aged 6 to 12 years, who were matched by gender, age, and school. The findings revealed that:

- (ASD) children had a higher percentage of problem-solving difficulties than non-(ASD) children (57% vs. 23%, respectively).

And (Carr, Seah, 2019) conducted a study titled "Mathematics Education for Students with Autism Spectrum Disorder: Where are we now?" It intended to discover whether people with ASD, the fastest-increasing category of people with impairments, have varying degrees of mental competence. When compared to their counterparts, students with autism are increasingly held accountable in the classroom. Applied Behavior Analysis (ABA) is largely regarded as the finest method for assisting these students. Twenty-six strategies for teaching mathematics in the single-state (SCD) classroom were carefully discovered and reviewed individually with students diagnosed with (ASD). The majority of the interventions were carried out in special education

mathematics classes with low-ability pupils. The findings revealed:

- The therapies were designed to improve simple arithmetic skills, and it was highlighted that research on more sophisticated mathematical skills was lacking.
- Teachers who teach (ASD) pupils claim that they have not undergone autism training.
- They talked about the after-work stress and the possibility of burnout as a result. Future study with highly capable mathematics students is needed, as is the relevance of a value model approach.

A study named "Convergent evaluation of working memory and arithmetic ability in a child with autism spectrum disorder without intellectual impairment" was undertaken by (Pellizzoni, Passolunghi, 2017). The specific purpose of this case report is to examine and combine findings on these two cognitive abilities in a child with (ASD) who does not have an intellectual handicap. Our findings on a 10-year-old autistic child reveal that functional levels (active vs. passive) rather than structural modifications (phonological vs. visual) are more suited to how the child performed in different activities. The results revealed that:

- That the levels of ability were from medium to good in calculating mathematics, with the exception of Multiplied by operation using oral language and using Divided.

Methods and Procedures

This section provides a detailed description of the study subjects, the method of selection, and a description of the Wechsler Intelligence Scale as a study tool. It also describes methods for verifying the validity and reliability of these tests, as well as the study method and data statistical analysis.

Research approach:

This study is based on the use of the descriptive correlative method for its suitability for the purposes of the study related to the skills of solving mathematical problems and the

achievement of students with (ASD), and its relationship to the arithmetic test of the Wechsler scale - 4.

Population and Sampling

The study population consisted of schools in which (ASD) students were integrated into the Kingdom of Saudi Arabia in the (central) region, where the number of autism schools reached (5) schools.

The study population consists, according to the age group (7-15) years, and the number of students with (ASD) in the (Middle) region. According to the statistics of the Ministry of Education for the year (2023).

Sample

The study population consisted of (18) students, and the purposive sample was chosen, as the student is studying in a public/private school for (ASD) in the Kingdom of Saudi Arabia in grades (second to fifth) and his age is (7-15) years. The following Table (1) shows the demographic distribution of the study sample by age, and the demographic Table (1) shows the distribution of subjects by age:

Table 1. Distribution of subjects (n=18) by Age and Gender

Age	Gender	Frequency	Ratio
7	Male	2	%11.11
8	Male	1	%5.55
9	Male	1	%5.55
10	Male	4	%22.22
11	Male	3	%16.66
12	Male	1	%5.55
13	Male	2	%11.11
14	Male	3	%16.66
15	Male	1	%5.55

Table (1) clearly showed that (11.11%) of the study sample individuals are (ASD) and their age is (7) years. And (5.55%) of the respondents are (8) years old. And (5.55%) of the respondents are (9) years old. The percentage of (22.22%) of the respondents is (10) years old, and the percentage of (16.66%)

of the respondents is (11) years old, and the percentage of (5.55%) of the respondents is (12) years old, and the percentage is (11.11%) of the respondents are (13) years old, and the percentage is (16.66%) of the respondents are (14) years old, and the percentage is (5.55%) of the respondents are (15) years old.

The study tools

The first tool: The Wechsler Children's Intelligence Scale (WISC-4), which (Abu Drei, 2017) performed Standardization a Jordanian Version for Deaf Via Sign Language.

Standard Description: The fourth version of the Wechsler Children's Intelligence Scale appeared in the year (2003) by (Williams, Weiss and Rothes, 2003). Evidence of validity, reliability, and standards was available in its primary form. The scale consists of 15 sub-tests:

- Block Design, Similarities, Digit Span, Picture Concepts, Coding, Vocabulary, Letter-Number Sequencing, Matrix Reasoning, Comprehension, Symbol Search, Picture Completion, Cancellation, Information, Arithmetic, Word Reasoning. (Wechsler, 2003).

Divided into four sub-measures:

1. (Verbal Comprehension Index, VCI) scale includes the following sub-tests: (Similarities, Vocabulary, Comprehension, Information, and Word Reasoning).

2. (Perceptual Reasoning Index, PRI) scale includes the following sub-tests: (Block Design, Picture Completion, Matrix Reasoning, and Picture Concepts).

3. (Working Memory Index, WMI) scale includes the following sub-tests: (Digit Span, Letter-Number Sequencing, and Arithmetic).

4. (Processing Speed Index, PSI) scale includes the following sub-tests: (Coding, Symbol Search, and Cancellation).

5. Full-Scale IQ (FSIQ) standard and includes tests: (VCI, PRI, WMI, PSI).

The second tool: a math test to detect mathematical steps for autism:

Mathematics scale to detect mathematical steps, which was developed by the researcher.

Scale description: This scale consists of a set of (4) sub-tests and (16) items.

The scale was prepared from the school mathematics curriculum, which was designed for this purpose, and it is composed of individual and collective scales.

The items on the scale were divided into:

- 1- Understanding the issue: the number of terms (4).
- 2- Developing a solution plan: the number of terms (4).
- 3- Implementation of the solution: the number of terms (4).
- 4- Verify the validity of the solution: the number of terms (4).

The third tool: the achievement of mathematics for students with autism.

Achievement of students with (ASD) in mathematics is through the grade list for each student at the school stage, and the total score is out of (100).

debug key:

The correction key and the degree of judgment on the achievement level of students with (ASD) were determined based on the following:

The key to correcting the level of student achievement:

The maximum mark for achievement = (100) and the lowest (0.00), and to find the level of student achievement, a correction key was reached to determine the level, which is based on the equation: the highest value - the lowest value / divided by the number of levels (3) (high, medium, low), and therefore the low level is from (0.00 - 33.3), the medium level is from (33.4 - 66.7), and the high level is from (66.8 - 100.0).

Mathematics test level correction key:

As for determining the level of the mathematics test, the maximum mark on the test was = (16.00) and the lowest (0.00). In order to find the level of the students on the mathematics test, a correction key was reached to determine the level, which is based on the equation: the upper value - the lower value / divided by the number of levels (3) (high, medium, low). Thus, the low level is from (0.00 - 5.33), and the average level is from (5.34 - 10.67). The high level is from (10.68 - 16.00).

Key to correcting the arithmetic test level of Wechsler Scale-4:

As for determining the level of students on the arithmetic test of the Wechsler scale - 4, the correction key was reached to determine the level, which is based on the equation the upper value - the lower value / divided by the number of levels (3) (high, medium, low). Thus, the low-level ranges from (0.00–11.33), and the average level ranges from (11.34–22.67). The high level is from (22.68-34.00).

Study Procedures

To achieve the objectives of the study, the following measures were taken:

- It was applied to the Pilot Study (n = 5) in order to verify the extent of linguistic formulation and the application and correction procedures.

The scales prepared for students with (ASD) were applied to a sample (n = 18).

1- The data were processed statistically according to the appropriate methods mentioned in the study.

3- The tests for autism were divided into categories according to the type of test (achievement, mathematical question-solving skills, Wechsler scale).

4- Indications about the validity and reliability of the scales were found.

Statistical treatment

To answer the study questions, the following statistical methods were used:

- Arithmetic means and standard deviations were used, and Pearson Correlation was used.
- The Pearson Correlation test and the Cronbach alpha test were used to ensure the validity and reliability of the measurement tools.
- The Multiple Regression test was used.

Results and Discussion

The study's findings were sorted into the following categories:

The First question: What are the indications of the Validity of mathematical problem-solving skills and achievement among autistic students, and its relationship to the arithmetic test of the Wechsler-4 scale?

The validity of the test of mathematical problem-solving skills and achievement of autism students and the arithmetic test of the Wechsler scale - 4 were verified. The following was used:

1- Content Validity

The scale's content validity was confirmed by presenting it to a group of (4) arbitrators with specialty and experience in the field of special education, (4) experts in the field of psychology, and (6) experts in the field of (ASD). Their comments on the scale's substance in terms of the clarity of the paragraphs and the language formulation, as well as the arrangement and sequence of the tests in light of the skills of kids with (ASD) to answer, validate the scale's apparent validity at an 80% rate.

- Indications of the validity of the mathematical problem-solving skills test for autistic students:

Pearson Correlation and Construct Validity were extracted to test the skills of solving mathematical problems, where the test consists of four main dimensions (understanding the

issue, developing a solution plan, implementing the solution, validating the solution), and each dimension includes four questions, and the correlation coefficient was extracted with the sign of each A question with the total sum of the marks for each dimension, as it was found that the value of the correlation coefficient of the marks for the first dimension, understanding the issue, was (0.887). In the second dimension, a solution plan was developed, which amounted to (0.774). And on the third dimension, implementing the solution (0.651), and on the dimension of validating the solution (0.578). They are statistically significant values at the significance level (0.01), which indicates the Construct Validity of the test.

- Indications of validity of achievement for students with autism:

The validity of achievement among (ASD) students has been verified through Content Validity, whereby schools adopt a number of skills and questions related to mathematics, and a number of appropriate tests for students with (ASD), as these tests are based on study materials within a course, and as a result of those tests and grades The achievement level of students with autism is determined, and mathematics has been reviewed for this category, and the researcher has found that the achievement stems from an educational material based on criteria specific to students with (ASD), which confirms Content Validity for the level of achievement of this group of students.

- Indications of the validity of the mathematics test from the Wechsler scale -4:

The indications of the validity of the mathematics test were relied on through the indications of the validity of arithmetic reasoning and the collection of many other data from the validity of the scale, which are indicated by several sources (Matarazzo, 1972; Anastasi, 1976; Freeman, 1962), and the multiple criteria that were dealt with in studies of the validity of school marks. However, regardless of the variety of disabilities or learning issues, the Wechsler-4 scale is

considered the most acceptable and best test for measuring arithmetic skills in children and adults. This demonstrates the Wechsler scale-4 mathematics test validity.

The Second question: What are the significances of Reliability, mathematical problem-solving skills and achievement among autistic students, and its relationship to the arithmetic test of Wechsler-4 scale?

The reliability of the study variables was checked as follows:

- Indications of the stability of the mathematical problem-solving skills test for autistic students:

To verify the reliability of mathematical problem-solving skills and achievement for students with (ASD), the arithmetic test of the Wechsler scale -4. The Cronbach alpha test was used, where the value of the Cronbach alpha coefficient for the scores of (ASD) students on the four-dimensional mathematical problem-solving skills test was (0.677). It is a value higher than (0.60), which is acceptable for the purposes of the current study (Hair et al., 2010).

- Indications of reliability of achievement among students with (ASD):

The reliability of achievement for autism students was verified through Cronbach's alpha test, where the value of the Cronbach alpha coefficient for (ASD) students' scores was (0.807). The reliability coefficient value is high and close to the value (1.00). This indicates the reliability of achievement among students with (ASD).

- Indications of the reliability of the Wechsler scale-4 mathematics test:

Wechsler scale-4 mathematics test reliability was verified by re-correcting the response scoring forms for eighteen of the Wechsler scale-related arithmetic test scores. It was calculated on each test, and each student had two marks, one on the odd number of students' marks, and the second on the odd number of students' marks, then both the odd and even grades were converted into a standard score

with an average (10) and a standard deviation (3), then the correlation coefficient between the standard scores was extracted individual and marital. The resulting value was corrected using the predictive Spearman-Brown equation. Where the value of the correlation coefficient was (0.791). It is an acceptable value for the purposes of the current study.

The Third question: What is the level of Mathematical problem-solving skills and achievement for autism students and its relationship to the arithmetic test of the Wechsler-4 scale?

To answer this question, the arithmetic means and standard deviations were extracted to identify the level of mathematical problem-solving skills and achievement among (ASD) students, noting that the maximum score for achievement = (100) and the lowest (0.00). In order to find the students' achievement level, a correction key was reached to determine the level, which is based on the equation: the upper value - the lower value / divided by the number of levels (3) (high, medium, low). Thus, the low level is from (0.00 - 33.3), the medium level is from (33.4 - 66.7), and the high level is from (66.8 - 100.0).

As for determining the level of the mathematics test, the maximum mark on the test was = (16.00) and the lowest (0.00). In order to find the level of the students on the mathematics test, a correction key was reached to determine the level, which is based on the equation: the upper value - the lower value / divided by the number of levels (3) (high, medium, low), and thus the low level is from (0.00 - 5.33).and the average level is from (5.34 - 10.67). The high level is from (10.68 - 16.00).

As for determining the level of students on the arithmetic test of the Wechsler scale - 4, the correction key was reached to determine the level, which is based on the equation the upper value - the lower value / divided by the number of levels (3) (high, medium, low). Thus, the low-level ranges from (0.00 - 11.33), and the average level ranges from (11.34 - 22.67). The high level is from (22.68-34.00), and Table (2) shows this:

Table (2): Means and standard deviations to identify students' achievement level, mathematics test, and arithmetic test for a sample of students with autism (n = 18)

test	Number	Minor degree	Grand degree	Arithmetic mean	standard deviation	Level
Achievement	18	0.00	100.00	86.22	7.80	High
Mathematics exam	18	0.00	13.00	5.44	5.07	Middle
Arithmetic test on the Wechsler scale	18	0.00	34.00	9.28	6.37	Low

Table (2) shows that the mean scores of students with autism reached (86.22) with a standard deviation of (7.80), which is from the high level. The average marks of (ASD) students on the mathematics test were (5.44) with a standard deviation of (5.07), which is from the average level. While it was found that the arithmetic mean of the scores of (ASD) students in the arithmetic test on the Wechsler scale was (9.28) and the standard deviation was (6.37), which is from the low level.

In order to reveal the relationship between the level of mathematical problem-solving skills, achievement, and arithmetic testing on the Wechsler scale for students with (ASD), and its relationship, correlation coefficients were extracted using Pearson Correlation, and its results are shown in the following table (3):

Table (3) Pearson correlation coefficients to reveal the relationship between mathematical problem-solving skills, achievement, and arithmetic testing on the Wechsler-4 scale

		Arithmetic test on the Wechsler scale - 4
Achievement	Pearson Correlation	.369
	Sig. (2-tailed)	.132
	N	18
Mathematics exam	Pearson Correlation	.268
	Sig. (2-tailed)	.283
	N	18

Table (3) shows that there was no statistically significant correlation between mathematical problem-solving skills, achievement, and arithmetic testing on Wechsler-4 scale for (ASD) students. Where the value of the Pearson correlation coefficient between achievement and the arithmetic test on the Wechsler scale = (0.369), and the value of the correlation coefficient between the mathematics test and the arithmetic test on the Wechsler scale = (0.268). They are non-statistically significant values at the significance level (0.05). The relationship, if positive, is between these variables, but it is not statistically significant.

The Fourth question: What is the effectiveness of the paragraphs for Mathematical problem-solving skills and achievement among autistic students, and its relationship to the Wechsler-4 scale arithmetic test?

To answer the third question of the study, a multiple regression test was used to detect the effectiveness of the paragraphs for mathematical problem-solving skills and achievement for (ASD) students in the Wechsler-4 scale arithmetic test. Table (4) shows this:

Table (4) Multiple regression analysis to identify the effectiveness of the paragraphs for mathematical problem-solving skills and achievement for autistic students in the Wechsler-4 scale arithmetic test

<i>regression coefficients</i>						Model Summary			
<i>source</i>	B	standard error	Beta	The calculated T value	T level of significance	R Correlation	R ²	value (F)	Statistical Significance
mathematical problem-solving	.097	.148	.163	.651	.525	0.400	0.160	1.429	0.270
achievement	.757	.602	.315	1.257	.228				

Table (4) shows that the value of the correlation coefficient for (the effectiveness of paragraphs) for mathematical problem-solving skills and achievement for students with (ASD) in the Wechsler scale arithmetic test = (0.400). It was also found that the paragraphs of mathematical problem-solving skills and achievement had an effectiveness in the arithmetic test of the Wechsler scale, with a rate of (R²) = (16%). It is a weak explanatory value that is not statistically significant at the significance level (0.05).

Through the results, it is clear that the statistical values (t) = (0.525, 0.228), respectively, for the effectiveness of solving mathematical problems, and the achievement in the arithmetic test of the Wechsler scale, respectively. They are non-statistically significant values at the significance level (0.05).

Accordingly, it turns out that there is no effectiveness of the mathematical problem-solving skills items and achievement for autism students in the Wechsler scale arithmetic test.

Discussion

1- What are the indications of the Validity of mathematical problem-solving skills and achievement among autistic students, and its relationship to the arithmetic test of the Wechsler-4 scale?

The results of the study showed evidence of validity in measuring mathematical problem-solving skills and achievement for students with (ASD), and the arithmetic test from the

Wechsler-4 scale, through Content Validity at a rate of (80%), and indications of the validity of the mathematical problem-solving skills test, as the test consists of four main dimensions, which are: (Understanding the issue, developing a solution plan, implementing the solution, verifying the validity of the solution) where it was found that the value of the correlation coefficient of marks for the first dimension, understanding the issue, was (0.887). On the second dimension, a solution plan was developed, which amounted to (0.774). And on the third dimension, the implementation of the solution (0.651). and after validating the solution (0.578). They are statistically significant values at the level of significance (0.01), which indicates the validity of the internal structure of the test, and indications of the validity of achievement by verifying the school's dependence on a number of skills and questions related to mathematics, and a number of appropriate tests for students with autism. Where these tests are based on study materials within a course, and the researcher found that the achievement stems from an educational material that depends on criteria for students with (ASD), which confirms Content Validity for the level of achievement of this group of students. And also, the indications of the validity of the mathematics test from the Wechsler scale -4 through the indications of the validity of the arithmetic reasoning, which indicates the validity of the mathematics test from the Wechsler scale -4.

- Researcher's interpretation: The validity parameters in any of the previous methods are

considered acceptable and good. This indicates that the scale has reliability indications that encourage its use in the Saudi environment.

2- What are the significances of Reliability, mathematical problem-solving skills and achievement among autistic students, and its relationship to the arithmetic test of Wechsler-4 scale?

The results of the study showed the availability of indications for the reliability of testing the skills of solving mathematical problems through the use of the Cronbach alpha test, which is higher than (0.60), which is acceptable for the purposes of the current study. Also, through the indications of the reliability of achievement, Cronbach's alpha test, where the students' scores were (0.807). The reliability coefficient value is high and close to the value (1.00), which indicates the reliability of achievement among (ASD) students. We also ran through the semantics of the reliability of the Wechsler-4 mathematics test by re-correcting the response scoring forms for eighteen of the scores related to the arithmetic test in the Wechsler scale. Where the value of the correlation coefficient was (0.791), which is an acceptable value for the purposes of the current study.

- Researcher's interpretation: The stability coefficients in any of the previous methods are considered acceptable and good. This indicates that the scale has stability indications that encourage its use in the Saudi environment.

3- What is the level of Mathematical problem-solving skills and achievement for autism students and its relationship to the arithmetic test of the Wechsler-4 scale?

The results showed that there is no statistically significant correlation between mathematical problem-solving skills, achievement, and arithmetic testing on the Wechsler-4 scale for a sample of (ASD) students. Where the value of the Pearson correlation coefficient between achievement and arithmetic test on the Wechsler scale = (0.369). The value of the correlation coefficient between the mathematics test and the arithmetic test on the Wechsler scale = (0.268).

They are non-statistically significant values at the significance level (0.05). The relationship, if positive, is between these variables, but it is not statistically significant.

The results agree with (Chen et al., 2019) with a decrease in the achievement of arithmetic skills. As well as all with (Bullen et al., 2022) that the performance was less than expected in mathematics. And with each (Polo-Blanco et al., 2022) that the percentage of autistic students who suffer from difficulties in solving problems was higher. And also, with (Pellizzoni, Passolunghi, 2017) that the levels of ability were from medium to good in mathematics calculation.

- Researcher's interpretation: Mathematics skills are very important for students with (ASD), but previous results showed that there is no correlation, which explains why the school is based on assisting students through (achievement) to increase the efficiency of the autistic student and raise his scores unrealistically for them. This demonstrates a lack of real ability among students with autism, which does not account for knowing their true talents, and that mathematics problem-solving skills were average, according to the researcher's experience in designing questions for children with (ASD). In addition, the Wechsler exam showed poor performance for the difficulty of the vertebrae in autism. This implies that math's issues for autistic students must be written rather than spoken.

4- What is the effectiveness of the paragraphs for Mathematical problem-solving skills and achievement among autistic students, and its relationship to the Wechsler-4 scale arithmetic test?

The results showed that the value of the correlation coefficient for (the effectiveness of the paragraphs) for the skills of solving mathematical problems and the achievement of students with autism in the arithmetic test from the Wechsler scale = (0.400). It was also found that the items of mathematical problem-solving skills and achievement had an effectiveness in the arithmetic test of the Wechsler scale, with a rate of (R²) = (16%). It is a weak explanatory

value that is not statistically significant at the significance level (0.05).

Through the results, it is clear that the statistical values $(t) = (0.525, 0.228)$, respectively, for the effectiveness of solving mathematical problems, and the achievement in the arithmetic test from the Wechsler scale, respectively, which are non-statistically significant values at the significance level (0.05).

Accordingly, it turns out that there is no effectiveness of the paragraphs of mathematical problem-solving skills and achievement among autistic students in the arithmetic test of the Wechsler scale.

- The results agreed with (Carr, Seah, 2019) that the interventions for math skills were simple. It was noted that there was a scarcity of research dealing with complex mathematical skills, and teachers also reported that they did not receive training in mathematical skills for students with (ASD), and this negatively affects the results of the tests.

- Researcher's interpretation: The current study found no link between the paragraphs, the sub-degree, and the total score, indicating that the scale does not have a high degree of effectiveness for the paragraphs.

Recommendations:

- Educational recommendations:
 - Math skills training for teachers of all disciplines for (ASD).
 - Solving mathematics issues in my own unique approach (both written and vocal).
 - Work on developing the steps for the autistic student's solution.
 - Using basic language while communicating with (ASD) students.
 - Assessing autism by evaluating the strengths and weaknesses of the greatest number of mathematical problem-solving processes.

- Suggestions for research purposes.
 - Conducting additional investigations and research on autism and its impact on mathematics.
 - Conduct research on the effects of intelligence and mathematical problem-solving abilities.
 - Conduct research on the effectiveness and impact of various communication strategies (oral language, writing, and facial expressions) on (ASD).

Reference

- [1] Abu Drei, S. (2017). Standardization A Jordanian Version of The Wechsler Intelligence Scale for Children-Adapted for Deaf Via Sign Language From (6-16, 11) years (Doctoral dissertation, Phd dissertation. Amman, Jordan: The Word Islamic Science and Education University).
- [2] American Psychological Association. (2015). Autism. Retrieved from <http://www.apa.org/topics/autism/>
- [3] Baron-Cohen, S., Wheelwright, S., Burtenshaw, A., & Hobson, E. (2007). Mathematical talent is linked to autism. *Human Nature*, 18(2), 125–131. doi:10.1007/s12110-007-9014-0
- [4] Bodin, D., Pardini, D. A., Burns, T. G., & Stevens, A. B. (2009). Higher order factor structure of the WISC-IV in a clinical neuropsychological sample. *Child Neuropsychology*, 15(5), 417-424.
- [5] Bull, R., Scerif, G. (2001) Executive functioning as a predictor of children's mathematics ability: Inhibition, switching, and working memory. *Developmental Neuropsychology*, 19, 273-293.
- [6] Bullen, J. C., Zajic, M. C., McIntyre, N., Solari, E., & Mundy, P. (2022). Patterns of math and reading achievement in children and adolescents with autism spectrum disorder. *Research in Autism Spectrum Disorders*, 92, 101933.
- [7] Carr, M. E., Moore, D. W., Anderson, A.: 2014, Self-management interventions on

- students with autism: A meta-analysis of single-subject research, *Exceptional Children* 81(1), 1–16.
- [8] Carr, M., & Seah, W. T. (2019). Mathematics education for students with autism spectrum disorder: Where are we now? *Annales Universitatis Paedagogicae Cracoviensis| Studia ad Didacticam Mathematicae Pertinentia*, 10, 17-39.
- [9] CDC, A. W. (2020). Centers for disease control and prevention.
- [10] Chen, L., Abrams, D. A., Rosenberg-Lee, M., Iuculano, T., Wakeman, H. N., Prathap, S., Chen, T., & Menon, V. (2019). Quantitative Analysis of Heterogeneity in Academic Achievement of Children with Autism. *Clinical Psychological Science*, 7(2), 362–380. <https://doi.org/10.1177/2167702618809353>
- [11] Chiang, H.-M., & Lin, Y.-H. (2007). Mathematical ability of students with Asperger syndrome and high-functioning autism: A review of literature. *Autism: The International Journal of Research and Practice*, 11, 547–556. doi:10.1177/1362361307083259
- [12] de Smedt, B., Janssen, R., Bouwens, K., Verschaffel, L., Boets, B., Ghesquière, P. (2009). Working memory and individual differences in mathematics achievement: a longitudinal study from first grade to second grade. *Journal of Experimental Child Psychology*, 103(2), 186 – 201.
- [13] Gathercole, S. E., Pickering, S. J., Knight, C., Stegmann, Z. (2004). Working memory skills and educational attainment: Evidence from national curriculum assessments at 7 and 14 years of age. *Applied Cognitive Psychology*, 18(1), 1 – 16
- [14] Gevarter, C., Bryant, D. P., Bryant, B., Watkins, L., Zamora, C., Sammarco, N.: 2016, Mathematics interventions for individuals with autism spectrum disorder: A systematic review, *Review Journal of Autism and Developmental Disorders* 3(3), 224–238.
- [15] Griswold, D. E., Barnhill, G. P., Myles, B. S., Hagiawara, T., Simpson, R. L.: (2002). Asperger syndrome and academic achievement. *Focus on Autism and Other, Developmental Disabilities* 17(2), 94–102.
- [16] Hair, J. F, Black, W. C, Babin, B. J, Anderson, R. E, and Tatham, R. L, (2010), “Multivariate Data Analysis”, 7th edition., New York.
- [17] Howlin, P., Goode, S., Hutton, J., & Rutter, M. (2009). Savant skills in autism: psychometric approaches and parental reports. *Philosophical Transactions of the Royal Society B: Biological*
- [18] Hussar, B., Zhang, J., Hein, S., Wang, K., Roberts, A., Cui, J., ... Dilig, R. (2020). The condition of education 2020. NCES 2020-144. National Center for Education Statistics.
- [19] Iuculano, T., Rosenberg-Lee, M., Supekar, K., Lynch, C. J., Khouzam, A., Phillips, J., Uddin, L. Q., Menon, V.: 2014, Brain organization underlying superior mathematical abilities in children with Autism, *Biological Psychiatry* 75(3), 223–230.
- [20] Jones, C. R. G., Happé, F., Golden, H., Marsden, A. J. S., Tregay, J., Simonoff, E., ... Charman, T. (2009). Reading and arithmetic in adolescents with autism spectrum disorders: Peaks and dips in attainment. *Neuropsychology*, 23(6), 718–728. <https://doi.org/10.1037/a0016360>
- [21] Kim, S. H., Bal, V. H., & Lord, C. (2017). Longitudinal followup of academic achievement in children with autism from age 2 to 18. *Journal of Child Psychology and Psychiatry*, 59, 258–267. doi:10.1111/jcpp.12808
- [22] Linden Bride School. (2014). Autism. Retrieved from
- [23] http://www.linden-bridge.surrey.sch.uk/asdinfo_list.asp?Section=301
- [24] Mayes, S. D., & Calhoun, S. L. (2008). WISC-IV and WIAT-II profiles in children with high-functioning autism. *Journal of Autism and Developmental Disorders*, 38(3), 428–439. <https://doi.org/10.1007/s10803-007-0410-4>
- [25] McCrimmon, A. W., & Smith, A. D. (2012). Review of the wechsler abbreviated scale of intelligence–Second

- edition (WASI-II). *Journal of Psychoeducational Assessment*, 31(3), 337–341.
- [26] McMullen, P.: (2000). The gifted side of autism, *Focus on Autism and Other Developmental Disabilities* 15(4), 239–242.
- [27] Pellizzoni, S., & Passolunghi, M. C. (2017). Convergent evaluation of working memory and arithmetic ability in a child with autism spectrum disorder without intellectual impairment. *Frontiers in Psychology*, 8, 1278.
- [28] Polo-Blanco, I., Suárez-Pinilla, P., Goñi-Cervera, J., Suárez-Pinilla, M., & Payá, B. (2022). Comparison of Mathematics Problem-Solving Abilities in Autistic and Non-autistic Children: the Influence of Cognitive Profile. *Journal of Autism and Developmental Disorders*, 1-13.
- [29] Prifitera, A., Weiss, L. G., Rolfhus, E., & Saklofske, D. H. (2005). The WISC-IV in the clinical assessment context. In *WISC-IV clinical use and interpretation* (pp. 3-32). Academic Press.
- [30] Sussman, F. (1999). *More Than Words*. Canada: A Hanen Centre Publication.
- [31] Wei, X., Christiano, E. R., Yu, J. W., Wagner, M., & Spiker, D. (2015). Reading and math achievement profiles and longitudinal growth trajectories of children with an autism spectrum disorder.