# Improving Mathematical Skills for Pupils with Specific Learning Disabilities

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**ABSTRACT:**

A consistent percentage of early school-aged children are diagnosed with specific learning disabilities (SLDs), which are neurodevelopmental disorders that affect specific areas of academic function and the capacity to perform and comprehend reading, writing, or arithmetic. The current study explores the effectiveness of a training program in developing the mathematics skills of pupils with Dyscalculia. Participants in this study are ten primary pupils between the ages of 9-11, divided equally among the experimental and control groups diagnosed with Dyscalculia. The general mental ability test, the rapid nerve screening test, the diagnostic assessment scale for mathematics disabilities, the dyscalculia scale, and the mathematical achievement test were used to diagnose Dyscalculia, and the training program was used to improve the mathematical skills in pupils with Dyscalculia. Results show statistically significant differences between the mean scores of the pupils of the experimental and control groups in mathematics skills in the post-measurement in favor of the experimental group, which means that the appropriate intervention can allow pupils with Dyscalculia to succeed at acquiring mathematical skills.

*Keywords:* Specific Learning Disabilities, Mathematics Skills, Dyscalculia, Neurodevelopmental Disorder, Specific Academic Skills.

## INTRODUCTION

Children learn many mathematical concepts and mathematical operations before they reach school age, known as informal knowledge, as some mathematical skills are basically innate but affected by the environment. Numerical awareness refers to fluidity and smoothness, flexibility in the child's handling of numbers, awareness of what those numbers mean, and the ability to perform mathematics mentally, look at the world, and make various comparisons, which is crucial. Numerical awareness leads to more fluidity in terms of mathematical information and the ability to solve problems numeracy when a child is enrolled in school, and the deficiency in numerical awareness is an inevitable consequence of the arithmetic disabilities that children experience (Hallahan, et al., 2007; Viesel-Nordmeyer et al., 2021).

Specific Learning Disabilities (SpLDs) are neurodevelopmental disorders that impede the ability to learn or use specific academic skills (American Psychiatric Association, 2013). It is usually associated with impairments in reading, writing, written expression, and mathematics, which are the foundation for other academic learning skills and affect 3%–10% of children in many countries (Kormos, 2020; McGill et al., 2016; Shah et al., 2019).

Dyscalculia is a sub-type of SpLDs known as mathematics disability. The Diagnostic Statistical Manual of Mental Disorders (American Psychiatric Association, 2013) defines Dyscalculia as "an alternative term used to refer to a pattern of difficulties characterized by problems processing numerical information, learning arithmetic facts, and performing accurate or fluent calculations" (p.79). It also refers to severe difficulty in understanding basic concepts that affect the acquisition of basic arithmetic skills and is due to a fundamental deficiency in the representation and processing of numerical information in the brain, despite the average intelligence, emotional stability, and academic opportunities (Hallahan, et al., 2007; Kroesbergen et al., 2023; Sudha & Shalini, 2014; Shalev, 2004; Salisa & Meiliasari, 2023).

Children with Dyscalculia can face problems in retrieving facts, estimating, counting back, understanding and applying the concept of time, understanding money handling, sequence, and direction left and right while observing number patterns, understanding and applying the language of mathematics, and might also have anxiety that may hinder learning mathematics and reaching their full potential (Butterworth et al. 2011; Zerafa, 2015).

Mathematics and its teaching methods represent the most important areas that affect the academic and mental cognitive performance of all students during the successive stages of growth, as these students must acquire a reasonable amount of academic and cognitive competence in the concepts and skills that enable them to successfully deal with problems and mathematical tasks and generalize them in real-life situations. Mathematics skills are essential for independent living in a numerical society, for educational and job opportunities, and consequently the economic and social situation across the lifespan (Shalev, 2004; Doyle, 2010; Zerafa, 2015).

Individuals with Dyscalculia can find problems in applying and generalizing mathematics skills during their dealings and treatments of mathematics. Therefore, it is necessary to consider the appropriate teaching methods while teaching them (Shalev, 2004; Kaufman, 2008; Doyle, 2010; Zerafa, 2015). They can also suffer from problems related to the skills of writing numbers, correct mathematical symbols, and counting, difficulty in implementing and performing mathematical operations and verbal problems, taking a long time to solve, high error rates, and difficulty remembering and recalling mathematical facts, related to deficiencies in working memory (Haberstroh & Schulte-Körne, 2019; Hobri et al., 2021).

There can be difficulty in performing working memory tasks that involve counting and remembering numbers, but not on non-numerical tasks, and these disabilities may worsen and persist with students in later periods unless appropriate intervention is done (Landerl, 2004). Consequently, these students require well-designed interventions to improve their arithmetic skills (Price & Ansari, 2013; Winkel & Zipperle, 2023).

In recent years, there has been a rapid development of modified programs that help alleviate some of these specific learning disabilities, especially those related to reading and math (Geary & Hoard, 2005; Gartland & Strosnider, 2020; Balu et al., 2015; Fletcher & Vaughn, 2009; Shin at al., 2023). There has been increasing progress in identifying the cognitive, genetic, and neurological mechanisms contributing to dyslexia and its diagnosis and treatment. However, it appears that research on Dyscalculia is slow due to the field's difficulty and complexity (Geary & Hoard, 2005; Onoshakpokaiye, 2021; Hobri et al., 2021).

Research has indicated that education that breaks down tasks into manageable chunks, uses a visual symbolic representation of numbers, and employs memory techniques such as multiple repetitions, realistic examples, one-to-one instruction, and instant feedback improves outcomes for individuals with Dyscalculia (Dowker, 2005; Doyle, 2010; Mariare et al., 2014; Vintere, 2021).

According to Mariare et al. (2014), intervention must be done early, and modified teaching programs must be designed to circumvent their weaknesses, and teachers must help students acquire and generalize concepts mathematical skills and gradually increase the difficulty of mathematical problems to help students progress to the abstract levels of mathematics in a sequence of the senses to reduce dyscalculia symptoms. Therefore, many studies have indicated that students who undergo quality, well-designed programs show significant improvement in their abilities at the end of the program (Rababah & Alghazo, 2016). Thus, this study aimed to explore the effectiveness of a training program in improving mathematical skills in pupils with Dyscalculia.

## METHOD

### Research Design

The current study uses a quasi-experimental design to examine how well training program activities (independent variable) develop math skills (dependent variable) in a sample of pupils with Dyscalculia. The students were split into two groups, one for the experiment and the other for control. The approach used was quantitative research design, and the main research issue was extended to the following specific issues: To what extent can mathematical skills be developed in children with Dyscalculia? The study was approved by the ethical committee, education faculty, and University (1/2023–16).

### Participants

The participants in this study consisted of 10 primary school pupils from the fourth and fifth grades enrolled in a primary school in Ismailia governorate, with a mean chronological age of (m= 9.67; SD= 0.37). The sample was divided into two groups: an experimental and a control group, with five pupils in each group. The homogeneity between the experimental and the control groups was validated through the Mann-Whitney test.

The participants were selected from an initial sample of (180) male and female pupils enrolled in a primary school in the Ismailia governorate based on teacher nomination, grade reports, and a series of assessments administrated by the researchers. First, pupils' teachers were interviewed to select pupils with clear disabilities in maths according to their class performance and math tests. The number of pupils proposed was (24) pupils. Accordingly, an achievement test in mathematics skills was also administered to ensure pupils' mathematical assessment scores were less than average, and accordingly (2) pupils were excluded due to their average scores on the mathematical achievement tests administered by researchers. For the remaining 22 pupils, the general mental ability test for 9-11 years was administered, excluding pupils with an IQ less than (90), as it was less than the average. As a result, only 17 non-excluded pupils were left, and a quick neurological screening test was used to identify the cases of learning disabilities. Pupils whose scores were less than (26) and absent pupils were excluded. Consequently, the final sample number was (10) pupils (7) males and (3) females, and the diagnostic assessment scale for mathematics disabilities and the dyscalculia scale were administered. Finally, as the results of administrated tests showed evidence of other disabilities or environmental deprivation in the remaining 10 participants, they were selected for this study, with a mean chronological age of (m= 9.67; SD= 0.37). Table 1 shows no statistically significant differences between the mean scores of the experimental and control groups in the study variables.

### Research Tools

The Researchers used the General Mental Ability Test by Musa, 1984 (level 9-11) to define the participant's IQ

Table 1. **The Significance of the Differences between the Experimental and Control Groups using the Mann-Whitney Test.**

| Variables | Z value | P value |
|---|---|---|
| Chronological age | 0.838 | 0.402 |
| General mental ability test | 1.56 | 0.117 |
| Neural screening test | 1.04 | 0.295 |
| Dyscalculia test | 0.105 | 0.916 |
| Addition skill | 0.976 | 0.329 |
| Subtraction skill | 0.113 | 0.910 |
| Multiplication skill | 0.219 | 0.827 |
| Division skill | 1.22 | 0.221 |

and the Rapid Neurological Screening Test (Mutii, Harold & Norma, 1978, translated and standardized by Kamel, 1989) to identify individuals with learning disabilities, and Diagnostic Assessment Scale for Mathematics Disabilities (Al-Zayat, 2007) to identify students with mathematics learning disabilities.

In addition, the researchers prepared the Dyscalculia Scale to identify students with Dyscalculia, the Mathematics Achievement Test to identify their math achievement scores in mathematical skills, and the training program to improve their mathematical skills. The description of these tools is as follows:

***Dyscalculia Scale***

The scale was developed after researchers reviewed several studies on numeracy problems, including Dowker (2005), Butterworth (2009), Mariare et al. (2014), Price & Ansari (2013), and Zerafa (2015). They also used the Difficulty Screener prepared by Butterworth (2003), the Sense of Number Screener by Jordan et al. (2008), the Difficulty Assessment Test, the computation list from Weaver (2014), and the setting from Lafayette Parish School system (2018) to prepare the scale items. The first draft of the scale consisted of 33 statements.

**Psychometric Characteristics of Dyscalculia Scale**

To verify the validity and reliability of the scale, it was applied to a rationing sample of (20) pupils with maths difficulties from the same primary school.

**1. Validity -** the scale was presented in its initial form to a panel of faculty members in the Department of Special Education and Educational Psychology for feedback on the scale expressions in terms of determining the appropriateness of the wording of the phrase and its association with Dyscalculia. Then, the validity of the criterion for the scale was calculated by calculating the correlation coefficient between the grades of the rationing sample students on the scale of computation, their scores on the diagnostic assessment scale for mathematics disabilities, and the value of the correlation coefficient was (0.765), which is a statistically significant function at the level of significance (0.01), which indicates that the scale is valid.

**2. Internal Consistency -** this was measured by finding the correlation coefficient between each item and the overall degree of the scale to ensure the homogeneity and coherence of the statements between them, as shown in Table 2.

Table 2 illustrates the values of the correlation coefficients between each of the scale items and the total degree of the scale as statistically significant values at the significance level (0.05). Accordingly, the integrity of the internal cohesion of the scale items is evident, which indicates that the scale has an acceptable degree of validity.

**3. Reliability -** reliability was calculated by the Cronbach alpha coefficients, where the reliability coefficient value reached (0.95), which is a high-reliability value. It is evident from the previous results that the scale has an acceptable degree of validity and reliability, which allows it to be used in the current research.

Finally, the scale consisted of (33) items aimed at detecting dyscalculia symptoms, and the teacher answered the scale of three (often - sometimes - rarely) and corrected in the order (1, 2, 3), and the more degrees the student gets, the more likely to have Dyscalculia.

Table 2. **Correlation Coefficients between each of the Scale Items and the Total Degree of the Scale**

| No. | correlation coefficients | No. | correlation coefficients | No. | correlation coefficients | No. | correlation coefficients |
|---|---|---|---|---|---|---|---|
| 1, | 0.615** | 10. | 0.472* | 19. | 0.481* | 28. | 0.467* |
| 2. | 0.823** | 11. | 0.635** | 20. | 0.483* | 29. | 0.803** |
| 3. | 0.857** | 12. | 0.489* | 21. | 0.552* | 30. | 0.753** |
| 4. | 0.744** | 13. | 0.477* | 22. | 0.845** | 31. | 0.615** |
| 5. | 0.620** | 14. | 0.536* | 23. | 0.857** | 32. | 0.654** |
| 6. | 0.820** | 15. | 0.792** | 24. | 0.472* | 33. | 0.507** |
| 7. | 0.523* | 16. | 0.753** | 25. | 0.472* | | |
| 8. | 0.652** | 17. | 0.621** | 26. | 0.472* | | |
| 9. | 0.553* | 18. | 0.481* | 27. | 0.846** | | |

** Significant at 0.05; ** Significant at 0.01*

***Mathematics Achievement Test***

The test aims to measure the students' achievement of basic mathematical skills (addition - subtraction - multiplication - division), which the students are expected to have mastered in previous years. The test was built so that each item measured an essential arithmetic skill and graded in difficulty.

The test consists in its initial form of four questions with (31) items and contains the four arithmetic skills (addition - subtraction - multiplication - division) as follows:

a) Addition skill: 7 questions (includes horizontal and vertical addition, using and without load).
b) Subtraction skill: 7 questions (includes horizontal and vertical subtraction, using and without borrowing).
c) Multiplication skill: 9 questions (it includes multiplication only and multiplication questions with division, subtraction, and addition).
d) Divide skill: 8 questions (it includes questions for horizontal and longitudinal division, with multiplication, subtraction, and addition).

**Psychometric properties of achievement test**

To verify the validity and reliability of the test, it was applied to a rationing sample of (20) pupils with mathematical disabilities from the same primary school.

**1. Validity -** the scale was presented in its initial form to a panel of faculty members in the Department of Special Education and educational psychology curricula and methods of teaching mathematics for feedback on the test items in terms of determining the suitability of the question formulation and its relevance to the purpose for which it was set. Their feedback was also sought on the clarity of the instructions and the extent of the appropriateness of its items for students with math disabilities. The panel feedback resulted in amending some linguistic formulations of some items.

**2. Internal Consistency -** this was measured by finding the correlation coefficient between each term and the degree of dimension it belongs to ensure consistency and coherence between the expressions, as shown in Tables 3 and 4.

It is evident from Table 3 that the values of the correlation coefficients between each test item and the degree of the dimension to which the item belongs are statistically significant values at the significance level (0.05), except for item No. (20) that is not significant, and it was excluded - the integrity of the internal coherence of the test vocabulary.

It is evident from Table 4 that the values of the correlation coefficients between the degree of each dimension of the test and the overall score are statistically significant

Table 3. **The Correlation Coefficients between each Test Item and the Degree of Dimension to which the Term Belongs.**

| No. | correlation coefficients | No. | correlation coefficients | No. | correlation coefficients | No. | correlation coefficients |
|---|---|---|---|---|---|---|---|
| 1. | 0.52* | 9. | 0.50* | 17. | 0.50* | 25. | 0.86** |
| 2. | 0.62** | 10. | 0.68** | 18. | 0.54* | 26. | 0.74** |
| 3. | 0.74** | 11. | 0.51* | 19. | 0.51* | 27. | 0.51* |
| 4. | 0.47* | 12. | 0.61** | 20. | 0.11 | 28. | 0.88** |
| 5. | 0.52* | 13. | 0.57** | 21. | 0.62** | 29. | 0.57** |
| 6. | 0.48* | 14. | 0.51* | 22. | 0.81** | 30. | 0.91** |
| 7. | 0.58** | 15. | 0.53* | 23. | 0.68** | 31. | 0.47* |
| 8. | 0.55* | 16. | 0.51* | 24. | 0.74** | | |

** significant at 0.05; ** significant at 0.01*

Table 4. **Correlation Coefficients between the Degree of each Dimension of the Test and the Overall Score**

| Dimension no. | First Dim. | Second Dim. | Third Dim. | Forth Dim. |
|---|---|---|---|---|
| Correlation coefficient | 0.59** | 0.51* | 0.76** | 0.69** |

** significant at 0.05; ** significant at 0.01*

Table 5. **Parameters of the Consistency of the Mathematics Skills Achievement Test with its Dimensions and the Total Score of the Test**

| Dimension no. | First Dim. | Second Dim. | Third Dim. | Forth Dim. | Test as total |
|---|---|---|---|---|---|
| Reliability coefficient | 0.73 | 0.75 | 0.68 | 0.70 | 0.82 |

values at the significance level (0.05). Accordingly, the integrity of the test's internal coherence is evident, which indicates that it has an acceptable degree of validity that allows it to be used in the current search.

**3. Reliability -** Alpha Cronbach coefficients calculated the reliability of the dimensions and the test's total score.

It is clear from Table 5 that the values of reliability coefficients ranged from (0.68 to 0.75) while the reliability of the test was (0.82), which are acceptable stability values. It is evident from the previous results that the test has an acceptable degree of validity and reliability, which allows it to be used in the current research.

The test was applied to the individuals of the rationing sample, and the average time spent by the students was (40) minutes, including reading the instructions and answering the test. The final form of the test and how to correct it the scale included in its final form (30) items with seven items for the skills of addition and subtraction and eight items for the skills of multiplication and division, and each correct answer takes two points, where the maximum score of the test becomes (60) points.

### The Training Program

The program aimed at developing basic arithmetic skills, such as addition, subtraction, multiplication, and division among students with Dyscalculia. The program relied on a set of techniques, teaching methods, and strategies, including training using a demonstration of illustrative examples in the program. A self-learning strategy was used while solving worksheets and homework, using discussion, questions, and a repetition strategy. Reinforcement was used as one of the program's techniques through physical and moral boosters. The researchers used pictures, colored drawings, and educational games.

Steps to prepare and implement the program: a) The literature and previous studies related to mathematics skills were reviewed (Thijsse, 2003; Mckenna et al., 2005; Haslam, 2007; Bell, 2010; Would, 2010; Mendaje, 2018); b) the number of sessions in the current program was determined through a review of previous studies, which suggested a training period ranging from four months to six months. C) The program's suitability for the category of maths impairment, their time ages, the tools and methods used, and the necessary adjustments were made. D) The program's content was divided into three phases, namely the introductory phase, the training phase, and the retraining phase, with a total number of (47) sessions and a final session.

The introductory stage included 5 group sessions where rapport was built between researchers and pupils to prepare them for the program. It also includes clarifying the purpose and importance of the program, with a general explanation of the steps followed and how to proceed in the program. The educational goals were specified as reviewing the sequence of numbers, reversing them, and reading and writing numbers in letters and symbols.

The training phase included 8 group training sessions with two sessions for each skill and 30 individual sessions distributed over the four arithmetic skills (addition - subtraction - multiplication - division) by (6) sessions for each skill of addition and subtraction and (10) sessions for the skill of multiplication, and (8) sessions for the skill of division.

The retraining phase included (4) group sessions, one session after each skill, to ensure their mastery before moving to the next skill.

Program evaluation: the formative evaluation was used during the implementation of the program at the end of each session, after the completion of each skill to ensure its acquisition, and a final evaluation after the completion of the application of the program by applying the mathematics skills achievement test. The training program was applied to the experimental group but not the control group.

## RESULTS

To verify the validity of the differences between the experimental group that received the training program and the control group that did not receive the training program in the mean ranks in the post-test on the mathematics skills achievement test with its dimensions and their statistical significance. Mann-Whitney non-parametric test was used to test the differences between the averages of the independent groups. Table 6 illustrates the significance of the differences between the mean scores of the experimental group and the control group in the post-measurement on

Table 6. **The Significance of the Differences between the Mean Scores of the Experimental and Control Groups in the Post-Measurement of the Mathematics Skills Achievement Test with its Dimensions and their Statistical Significance (n = 5)**

| Variables | Experimental group | | Control group | | Z value | P value |
|---|---|---|---|---|---|---|
| | Mean rank | Sum of ranks | Mean rank | Sum of ranks | | |
| Addition skill | 7.80 | 39.00 | 3.20 | 16.00 | 2.46 | 0.014* |
| Subtraction skill | 7.60 | 38.00 | 3.40 | 17.00 | 2.24 | 0.025* |
| Multiplication skill | 8.00 | 40.00 | 3.00 | 15.00 | 2.63 | 0.008** |
| Division skill | 7.40 | 37.00 | 3.60 | 18.00 | 2.13 | 0.033* |
| Total | 8.00 | 40.00 | 3.00 | 15.00 | 2.63 | 0.008** |

** significant at 0.05; ** significant at 0.01*

the mathematics skill achievement test with its dimensions and statistical significance equal (z= 2.46, P= 0.014) for addition skill; (z= 2.24, p= 0.025) for subtraction skill; (z= 2.63, p=0.008) for multiplication skill; (z = 2.13; p= 0.033); the total test degree (z= 2.63; p= 0.008).

There are statistically significant differences between the mean ranks of the experimental group students with difficulty in arithmetic in the pre-and post-test in mathematics skills in favor of the post-test. Wilcoxon non-parametric test was used. It is evident from Table 7 that there are statistically significant differences between the mean scores of the experimental group with Dyscalculia in the pre and post-test in mathematics skills (addition - subtraction - multiplication) and the total score in favor of the post-test, where the values of (Z) reached respectively (2.06, p=0.039; 2.04, p= 0.041; 2.04, p= 0.041) which are statistically significant values at the level of significance (0.05), while there were no statistically significant differences in the skill of division after applying the program, as the value of (Z) was (1.84, p=0.066), which is a value not statistically significant at the level of significance (0.05). The total test degree was (z= 2.03; p= 0.042).

Furthermore, it is evident from Table 8 that there are no statistically significant differences between the mean ranks of the degrees of the experimental group with computation difficulties in the post and follow-up test in mathematics skills (addition - subtraction - multiplication - division) and the total score, where the values of (Z) reached respectively (1.41, p= 0.157; 1.00, p= 0.317; 1.89, p=0.059; 0.447, p=0.414) which are statistically insignif-

Table 7. **The Significance of the Differences between the Mean Scores of the Experimental Group in the Pre and Post-Measurements on the Math Skills Achievement Test with its Dimensions and Statistical Significance.**

| Variables | Experimental group n=5 | | | Z value | P value |
|---|---|---|---|---|---|
| | Rank | Mean rank | Sum of ranks | | |
| Addition skill | Negative rank | 0.00 | 0.00 | 2.06 | 0.039* |
| | Positive rank | 3.00 | 15.00 | | |
| Subtraction skill | Negative rank | 0.00 | 0.00 | 2.04 | 0.041* |
| | Positive rank | 3.00 | 15.00 | | |
| Multiplication skill | Negative rank | 0.00 | 0.00 | 2.04 | 0.041* |
| | Positive rank | 3.00 | 15.00 | | |
| Division skill | Negative rank | 0.00 | 0.00 | 1.84 | 0.066 |
| | Positive rank | 2.50 | 10.00 | | |
| Total | Negative rank | 0.00 | 0.00 | 2.03 | 0.042* |
| | Positive rank | 3.00 | 15.00 | | |

** significant at 0.05*

Table 8. **The significance of the differences between the mean scores of the experimental group with Dyscalculia in the post and follow-up measurements on the math skills achievement test in its dimensions and statistical significance.**

| Variables | Experimental group n=5 | | | Z value | P value |
|---|---|---|---|---|---|
| | Rank | Mean rank | Sum of ranks | | |
| Addition skill | Negative rank | 0.00 | 0.00 | -1.41 | 0.157 |
| | Positive rank | 1.50 | 3.00 | | |
| Subtraction skill | Negative rank | 0.00 | 0.00 | -1.00 | 0.317 |
| | Positive rank | 1.00 | 1.00 | | |
| Multiplication skill | Negative rank | 2.50 | 10.00 | -1.89 | 0.059 |
| | Positive rank | 0.00 | 0.00 | | |
| Division skill | Negative rank | 2.00 | 2.00 | -0.447 | 0.655 |
| | Positive rank | 1.00 | 1.00 | | |
| Total | Negative rank | 2.25 | 4.50 | -0.816 | 0.414 |
| | Positive rank | 1.50 | 1.50 | | |

icant values at the level of significance (0.05) and the total test degree (z= 0.816; p= 0.414). Hence, it is evident from the previous results the effectiveness of the training program in developing Mathematics skills for students with Dyscalculia.

## DISCUSSION

The present research aims to evaluate the effectiveness of a training program in improving mathematical skills for Pupils with Dyscalculia. This study's findings indicate the program's effectiveness in developing mathematics skills such as addition, subtraction, and multiplication in children with Dyscalculia. These results are consistent with the results of both studies (Hughes, 1994; Would, 2010) that concluded the effectiveness of mathematical activities in developing numeracy skills for students with learning disabilities. The activities used in this study focused on task analysis strategy, where the tasks are divided into smaller units, using memory techniques, which include the repetition strategy and the visual representation of numbers (Doyle, 2010).

The current program's activities also allowed pupils to start from a lower level of their skills, which contributed to their confidence in their abilities to complete the various activities, easing their transition during the implementation of the current program. This contributed to improving the pupils' performance and their ability to solve arithmetic problems.

The program's implementation of individual learning had a prominent effect in considering the individual differences between students, as each student tackled each problem according to their own pace and speed by completing their worksheets. These results agree with those of Dowker (2005) and Mariare et al. (2014), which indicate the effectiveness of using individual learning for people with numeracy problems in developing their mathematics skills.

The previous results also reflect the current program's reliance on self-learning, which is one of the cognitive training strategies used with children with specific learning disabilities, as it aims to increase the student's awareness of the problem-solving stages while performing the tasks that require problem-solving and urging them to express these stages verbally (Hallahan et al., 2007). It helped pupils to become independent in learning and to progress smoothly while solving mathematical problems. As a result, students developed self-motivation and self-reliance and completed most homework assignments easily.

The previous results indicate the program's effectiveness in developing mathematics skills for students with Dyscalculia in addition, subtraction, and multiplication but not division. This might be explained by the fact that people with Dyscalculia have difficulty grasping mathematical concepts and skills, requiring a longer mastery time than their peers. This aligns with Hughes's (1994) conclusion that some mathematical activities significantly affected conceptual knowledge, application skills, and the total sum of mathematics but had less impact on numeracy skills such as division. Mariare et al. (2014) indicated that children with numeracy difficulties may reach age-appropriate levels of achievement after a period of specific training in mathematics, while those with Dyscalculia are less likely when using the same intervention.

The responses of the pupils indicated several critical elements to the program such as the use of a comfortable starting point, where they started at a skill below their ability to gain confidence in themselves and then continued the program with high motivation, has contributed to the ease of implementation by the researcher, the happiness of the students when starting from easy and simple worksheets that they could easily solve what contributed to reducing their anxiety (Butterworth et al., 2011; Thijsse, 2003; Vintere, 2021; Zerafa, 2015).

The mathematical activities used in this study are also based on a task analysis strategy in which tasks are divided into minor problems that gradually increase as it helps pupils to logical and orderly progress in skills and flexibility while solving worksheets, and the use of the repetition strategy, which had a clear impact on developing memory, storing computational information easily, and developing students' ability to retain information and computational concepts that were dealt with in the program, as indicated by Oakley et al. (2003). They pointed to the importance of the iteration strategy for children with specific learning disabilities.

The previous results are also in agreement with those of the Dowker study (2005) and Mariare et al. (2014), which concluded that the use of individual learning for students with Dyscalculia contributes to the development of their Mathematical skills, as it is compatible with the cognitive situation of each student, and in which each student works according to their own speed, taking into account the individual differences between them.

While these strategies were important for the program, the study also revealed individual differences within our small sample. It is noticeable during the application of the program that some pupils with Dyscalculia used to constantly reverse numbers, especially number (9) and number (4) while writing them, and they also reversed numbers in determining their spatial value, such as (23) written (32). Some/A number of pupils also demonstrated difficulties with memory, as they often forgot information quickly and found it difficult to remember some information. This is consistent with having severe deficiencies in numeracy skills due to deficiencies in processing the basic numbers or the sense of numbers, a deficiency in the representation and processing of numerical information in the brain (Price & Ansari, 2013; Zerafa, 2015). In addition, some pupils with Dyscalculia in this study had a slight decrease in their division skill that did not reach the level of statistical significance due to their severe difficulty in retrieving basic facts from long-term memory, a deficiency in the ability to represent audio and semantic information in long memory (Geary & Hoard, 2005). These findings are in agreement with the findings of Mariare et al. (2014) that some people with Dyscalculia are more resistant to intervention, and their gains tend to deteriorate somewhat over time, in contrast to the set of disabilities that tend to be retained.

The program's activities were a flexible and sequential method that made the student responsible for learning and aimed to provide each student with an educational path that better meets his individual needs (Mendaje, 2018). That helped to reach the previous result was the continuity of the evaluation during the sessions, the keenness to achieve the highest degree of mastery and accuracy, and the follow-up of the homework and assignments required of them, with the continuous moral and material strengthening of the students and their continuous encouragement. All played a role in the program's impact.

## CONCLUSION

This research explores the effectiveness of a training program to improve mathematical skills in pupils with specific learning disabilities, particularly Dyscalculia. The study used different instruments to assess Dyscalculia, such as the general mental ability test, the rapid nerve screening test, the diagnostic assessment scale for mathematics disabilities, the dyscalculia scale, and the mathematical achievement test. The training program focused on tailored activities that grasped the pupil's interest and motivated them to achieve higher mathematical skills. The most important finding of this study was the ability of pupils with Dyscalculia to gain mathematical skills, which may help reduce the symptoms of Dyscalculia resulting from the effective intervention. The implementation of mathematical intervention strategies resulted in a significant improvement among pupils with Dyscalculia, leading to a reduction in their anxiety towards mathematics and a more positive approach to learning the subject. Additionally, their overall achievement in mathematics has shown marked improvement.

## LIMITATIONS AND FUTURE RESEARCH

One limitation of this study is the small sample size. Based on the previous research intervention used with children with specific learning disabilities, time, effort, and working individually with the children may support the small sample size in this study. Furthermore, some measurements used in this study were old. The researcher addressed this point by calculating the validity and reliability of these scales. However, further research is needed with a larger sample size and in designing new measurements and scales to diagnose Dyscalculia.

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