

Developing a Scale to Diagnose Math Learning Disabilities among Fourth Grade Students in Saudi Arabia

بناء مقياس لتشخيص صعوبات التعلم في الرياضيات لدى طلاب الصف الرابع الابتدائي في المملكة
العربية السعودية

Developing a Scale to Diagnose Math Learning Disabilities among Fourth Grade Students in Saudi Arabia

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Abstract: This study aimed at developing a scale to diagnose math learning disabilities among fourth grade students in Saudi Arabia, the sample of the study consisted of (1080) students of fourth grade in Jeddah governorate, in order to achieve the goals of the study a test has been developed as a measurement to diagnose math learning disabilities, the test included four areas: concept of numbers, operations of numbers, concept of fractions, geometry and measurement. Results showed that the scale has adequate validity and reliability indicators, also it showed adequate correlation coefficients between each item's performance and the area it belongs to, which achieves paragraphs' effectiveness. In the light of the findings a set of recommendations was presented.

Keywords: scale, diagnoses, mathematics disabilities.

Introduction:

Recently, many Arab countries are concerned about providing all health, psychological, and educational services to the children who suffer from learning disabilities in the elementary school. This concern is resulted from the continuous increase in the numbers of these children in various Arab educational systems, ignoring such concern will lead to exacerbate the problem in a complex way which will make it difficult for experts to overcome and treat it [1].

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ملخص: هدفت الدراسة الحالية إلى بناء مقياس لتشخيص صعوبات التعلم في الرياضيات لدى طلاب الصف الرابع الابتدائي في المملكة العربية السعودية، تكونت عينة الدراسة من (1080) طالبا من طلاب الصف الرابع الابتدائي في محافظة جدة، ولتحقيق أهداف الدراسة تم بناء اختبار كمقياس لتشخيص الصعوبات الخاصة بالرياضيات، وقد شمل الاختبار أربعة مجالات هي: مفاهيم الأعداد، العمليات على الأعداد، مفهوم الكسور، الهندسة والقياس. وأشارت النتائج إلى تمتع المقياس بدلالات صدق وثبات مناسبة كما بينت أن معاملات التمييز ومعاملات الارتباط بين الأداء على كل فقرة والمجال الذي تنتمي مناسبة وهذا يحقق فاعلية الفقرات. وفي ضوء نتائج الدراسة قدمت مجموعة من التوصيات. **كلمات مفتاحية:** مقياس، تشخيص، صعوبات الرياضيات.

Early detection of learning difficulties for elementary stage students is considered necessary for their development in the following years, in which it helps in identifying and determining them in providing the adequate interfering programs, taking the required preventive procedures to limit that difficulties and its spread in the future, the more early identification the more easy to overcome these difficulties [2].

Math learning disabilities are considered one of the main learning disabilities together with writing and linguistic

difficulties, researches that tackled math learning difficulties are considered limited when compared with major researches which dealt with learning disabilities in reading and writing, it is one of the major types of problems shown by learning disabilities' children and categorized within academic learning disabilities [3].

Workers in the field of education in general and special education in particular agree to help students with math learning disabilities, but the main problem that face the workers in the field of education and mathematics in particular lies in the difficulty of finding the scale or the scientific tool that helps them to identify those students who suffer from math learning disability, lack of proper diagnosis usually leads to describe the student as lazy and careless. As a result of lack of proper diagnosis and adequate special services for these cases, most results usually are with negative attitudes; as if the student surrenders to the learning disability, consequently his academic achievement in mathematics will decline. Some students may be forced to deliberately miss the school of the mathematics lesson to avoid frustrating classroom situations, which may also lead to accumulative frustrations and failures [1].

Therefore, this study tries to build a test to diagnose the disabilities of mathematics among fourth grade students in order to identify those students and types of those disabilities.

Questions and Problem of the study:

The problem of the study lies in diagnosing math learning disabilities among fourth grade students by developing a scale looks like a test, therefore, the problem of the study lies in the main question:

Is it possible to develop a scale to diagnose math learning disabilities among fourth grade students?

The following sub-questions emerge from the main one:

- What are the achieved validity indicators for math learning disabilities diagnosis test among fourth grade students?
- What are the achieved reliability indicators for math learning disabilities diagnosis test among fourth grade students?
- What is the effectiveness of the paragraphs that form the math learning disabilities diagnosis test among fourth grade students?

Objectives of the study:

This study aims at:

- Building math learning disabilities diagnosis test among fourth grade students.
- Finding the achieved validity indicators for math learning disabilities diagnosis test among fourth grade students.
- Finding the achieved reliability indicators for math learning disabilities diagnosis test among fourth grade students.
- Identifying the effectiveness of the paragraphs that form the math learning disabilities diagnosis test among fourth grade students.

Importance of the study:

The process of identify learning disabilities in general, and identifying the type of disability in particular, are the most important steps to detect students with learning disabilities, and the main platform that enable us to identify them, which require providing adequate measuring and diagnosis tools that enable the regular teacher and the special education teacher: to identify those students, to provide proper educational services which suit them, or to transfer them to the specialized

authorities to receive these services [5], because judging the child as having a learning disability has serious consequences in guiding his life and determining his future, Ashor [6] indicating Sheiffman's study about students suffering from mathematics learning disabilities, which found that early detection of those students in early stage and providing them with effective treatment programs in elementary stages has led to significant enhancement by (84%), while the enhancement rate declines to (46%) if diagnosis and treatment were done at the end of the elementary stage. Also, enhancement rate will not exceed (18%) if learning disability students were detected and received the treatment educational programs in the middle stage. If detection and treatment were done at the end of the middle stage, then the enhancement rate will not exceed (8%) only. Based on that, the importance of this study appears at:

- Its attempt to provide a tool to diagnose math learning disabilities among elementary stage students.
- Emphasizing on students with math learning disabilities.
- Drawing attention to the necessity of early interference and detection for learning disability cases.

Limitations of the study:

This study was limited to fourth grade students attending school in the public schools of Jeddah department of education during the first semester of the academic year 2017/2018.

Definition of Terms:

Math learning disabilities: Disrupted ability to learn mathematical concepts and to perform the related mathematical operations [7]

Within this study, it is defined with that difficulties in mathematics detected

through students' performance on learning disabilities diagnosis scale developed in this study.

Measure: the process based on giving numbers or employing it according to a particular system for quantitative evaluation of a feature or a specific variable [8].

In this study, it is defined as the tool by which we can know how much features and properties the student have regarding math learning disabilities.

Diagnosis: categorizing the students who need comprehensive diagnosis to confirm or deny their special needs and to determine the type of that needs [9].

In this study, it is defined as the process that determine the indicators of math learning disabilities suffered by students, and the type of that disabilities.

Previous Studies and Literature Review:

Literature review:

Math learning disabilities

Math learning disabilities is one of the main learning disabilities besides linguistic and written disabilities. Researches on math learning disabilities are few compared to many researches that dealt with learning disabilities in different language skills. As a result of these researches, it has been found that math learning disabilities are related to the linguistic disabilities. This link appears in some Dyslexia definitions as a fundamental cognitive disability [10]. In Miles & Miles [11] found that linguistic and mathematics disabilities were found accompanying each other most of the times, despite the possibility, although there may be students with severe reading disabilities but with no math disabilities and they show strong mathematical thinking ability.

Math learning disabilities refer to several factors, some of it were proven and some were only assumptions, those factors are: brain injuries, asymmetry of brain's hemispheres, genetic factors, nutritional and environmental deprive, inability to read math in school books, shortage of recognition, memory disorders, inability to process data, lack of knowledge about math fundamentals, difficulty in determining the required process to solve the questions [12].

Students diagnosed with learning disabilities suffer from one or more of the following problems during math learning: linguistic difficulties, audio and visual difficulties, difficulty in recognizing the shape or its background, difficulties in differentiating, reverse in order, spatial difficulties, memory difficulties, difficulties in sequencing, difficulties in expression, difficulties in attention, difficulties in categorizing, dispersibility, and fear of math [10].

Previous Studies:

Awn and Ata'allah [13] study aimed at identifying the most difficult area in learning math among fourth grade students according to math book. Sample of the study consisted of (40) teachers. Findings showed difficulties among fourth grade students in: numbers, mathematical operations, geometry, and problem-solving, measurement.

Lashhab [14] conducted a study to develop achievement test to diagnose math learning difficulty among a sample of second grade students with attention disorders. Sample of the study consisted of (60) students, the study found that difficulty areas were as follows, in descendent order: deduction and analyzing, knowledge, comprehension, and implementation.

Mujahidi and Jallab [15] developed a scale to diagnose students of developmental learning disabilities. The sample of the study consisted of (20)

students from special education sections. The study concluded to control scale's psychometric characteristics of validity and reliability to become usable in the field for which it was designed.

Althbaiti [16] conducted a study aimed to developing a scale to diagnose learning disabilities among first third levels of the elementary stage in Alta'if city. Sample of the study consisted of (144) students. Findings indicated the validity of the applying the scale by verifying the availability of psychometric characteristics, the extracted tool measurements were accepted to detect learning disabilities.

Ghafour [3] conducted a study to identify the difficulties facing third grade students in solving math equations made by teachers, from the students' perspective. Sample of the study consisted of (80) students. Findings showed that the difficulties facing the students were represented in confusing between math formulas, lack of math question solving methods, and not understanding the question.

Sawalha [17] conducted a study to identify the patterns of common math mistakes among math learning disability students in resources' rooms. The sample of the study consisted of (140) male and female students of math learning disabilities, the researcher developed a mathematical diagnosing-test which was implemented on the sample of the study, and performed one-to-one interviews. Results showed mistakes in concepts, algorithms, and facts of addition, subtraction and multiplication, there were significant statistical differences between fourth and third grade students, in favor of third grade, and between males and females, in favor of males, and there were no significant statistical differences ascribed to the interaction between gender and class.

Jibreel [18] conducted a study to build math learning disability diagnosis scale for Jordanian students at basic stage. Population of the study consisted of all students of fourth, fifth, and sixth basic grades who suffer from learning disabilities in general, findings of the study showed acceptable percentages for linguistic wording and item's correlation coefficients, and the test was valid to be used as a tool for measurement and diagnosis.

Commenting on the previous studies:

By reviewing the previous studies, we note that recently there has been an increasing interest in building measures for learning disabilities diagnosing, as most of the studies were recent, this indicates the importance of learning difficulties diagnosing in general and diagnosing the difficulties of math in particular despite the lack of studies compared to other categories of disabilities. The researchers benefited from the previous studies in forming the problem of the study and the questions, building the test, procedures, and selecting the adequate statistical methods, also, in the presentation and discussion of the results.

Method and procedures:

In this party of the study we describe the population of the study and method of selecting, tool of the study, procedural steps taken by the researchers, it also includes the limitations, design, and the statistical processing for the study.

Population and Sample of the study:

The population of the study consisted of all fourth grade students attending school during the academic year 2017/2018 at governmental schools of Jeddah directorate of education. A representative sample was selected based on multi-stage stratified sample as follows: Jeddah governorate was divided into three regions (north, middle, and south). Three schools

were chosen randomly from the each region's list of schools, total number of schools was nine, each school contains an average of four branches of the fourth grade, each branch contains in general 30 students, the sample of the study consisted of (1080) students.

Tool of the Study:

The researchers developed a measure to diagnose the math disabilities among the study sample of fourth grade students, according to the following steps:

First step: determining the fields and math difficulties, in this step. A list of the learning difficulties in math was achieved, which will be measured to find the level of the fourth grade and for each field of math. Also, in this step, the subjects which the scale will measure were determined based on that list. This was done by referring to a number of special scales to detect learning disabilities in math, such as K-math.

Special topics of math learning were determined based on what learning disability children are suffering from while learning math, which was mentioned in the literature review, especially in Bley and Thornton book [19], the test included four areas: concept of numbers, four operations, fractions concept, geometry and measurement.

Second step: building the scale. After determining math learning disability areas and the topics which will be tacked to measure these disabilities, the researchers built the scale based on multiple-choice objective-questions, phrased each question containing one of math learning disabilities, each question followed by four choices representing patterns of math learning disability which were indicated in experimental and theoretical literature, (65) paragraphs were formed on four areas for fourth grade representing the draft copy of the scale.

Third step: pilot study. After finishing the second step, the draft test was implemented on randomly selected sample of (60) students of fourth grade. In this stage, vague paragraphs or words were determined, the time that 75% of students spend to answer all the questions was recorded, 70% of the sample needed 1.5 lesson which equals (65) minutes to answer all the questions, instruction clarity was verified by calculating the coefficient of each item's difficulty and the discrimination coefficient, paragraphs with discrimination coefficient less than (0.3) were eliminated, paragraphs with difficulty coefficient more than (0.9) or less than (0.02) were eliminated, after this phase; scale's paragraphs became (56) paragraphs.

Fourth step: adequacy of paragraphs to the age, modern math book of fourth grade was analyzed in this step, paragraph that does not fit the grade has been deleted, so the paragraph level should not exceed the student level. Accordingly, the number of paragraphs became (50) paragraphs.

Fifth step: verifying the validity indicators, test's validity indicators were achieved by verifying the content, which was verified by procedures followed while building the test, the test was presented to a some of specialized and experienced reviewers; their opinions were taken into consideration regarding paragraphs' linguistic formation and adequacy for the four areas included by the scale: concept of numbers, operations of numbers, concept of fractions, geometry and measurement.

Therefore, and by taking reviewers consensus coefficient of (75% or more) in terms of paragraph linguistic phrasing, relativity to the area, and adequacy for the measured difficulty, the final version of the test consisted of (46) paragraphs.

Sixth step: main experiment process, achieving test's validity and reliability

indicators according to the following procedures:

First: validity procedures:

Authors achieved validity as

1. Content validity: achieved by the fifth step of scale's building steps.

Scale's construct validity: in this step, scale's integral validity as verified before implementation by finding the correlation coefficients between the scale and math basic skills diagnosis scale for the basic stage, built by Jibreel [18], both tools were implemented on a sample consisted of (40) students, correlation coefficient between total score for the tool and total score for math area in Jibreel scale [18] were calculated.

2. Discrimination validity for the scale: means were calculated for shared paragraphs of each scale's areas, all differences were found statistical significant by using (t-test).

Second: reliability procedures:

Test and Retest: to achieve test reliability with retest the researchers repeated the implementation of the test on a sample of (75) students from the main sample, after two weeks of main test implementation, where reliability coefficient was (0.925).

Cronbach's Alpha method: reliability was calculated by Cronbach's Alpha method for the main sample consisting of (1080) students, reliability coefficient on the scale was (0.915).

Procedures of the study:

Survey study was performed for schools, addresses were obtained from Jeddah School's directory.

Letters were written to principals in order to facilitate the researchers' mission.

Answer forms were prepared to fill the answers electronically.

The researchers applied the tool (Math Learning Disabilities Diagnosis Scale) on

the targeted category with the help of math teachers in the targeted schools after stating the goals of the scale and the method of application, duration lasted for five weeks; two schools each week.

Statistical Processes:

SYSTAT program was used to obtain the following:

Paragraph’s effectiveness: the researchers identified paragraph’s effectiveness by calculating the discrimination coefficients for each paragraph of the scale by studying the correlative relationship between the performance on the paragraph with the score of its level and the total score for the scale, the same was done for the difficulty coefficients.

Validity indicators: after achieving the content validity, the researches extracted the construct validity and the discriminative validity.

Reliability indicators: scale’s reliability was achieved by the following:

- Test-Retest Reliability.
- Cronbach Alpha.

Findings and discussion:

It includes a presentation for the findings of the study to answer the questions of the study.

Results related to the first question:

What are the achieved validity indicators for math learning disabilities diagnosis test among fourth grade students?

Scale’s validity was verified by using the following methods:

Content validity: content validity indicators were achieved by collecting scale arbitration forms for each area, arbitration results showed that the consensus on linguistic phrasing for each area paragraphs ranged between (83%) for fractions area and (91%) for concept of numbers area, which is adequate for the purpose of this study, as for paragraph’s coherence to each area and adequacy for the measured difficulty the percentage ranged between (77%) for fractions area and (94%) for geometry and measurement area, in general it was (86%) which is adequate for the purpose of this study.

Construct validity: correlation coefficients were calculated between performance on the areas of the current study scale

By calculating the correlation coefficients between the scale areas of the current study and math basic skills diagnosis scale, built by Jibreel [18], total score on (40) students scout sample of features similar to the sample of the study. Table (1) shows the related correlation coefficients.

Table (1) correlation coefficients.

Area	Numbers	Facts of counting	calculation numbers	Whole fractions and numbers	Decimal	Percentages	Measurement	Charts	Total score
Concept of number	0.83	0.65	0.62	0.47	0.48	0.46	0.44	0.43	0.65
Fractions	0.45	0.53	0.46	0.74	0.72	0.53	0.52	0.48	0.56
Operations of number	0.66	0.65	0.84	0.53	0.56	0.59	0.58	0.51	0.71
Geometry and measurement	0.54	0.45	0.63	0.55	0.49	0.49	0.88	0.67	0.72
Total score	0.66	0.73	0.74	0.68	0.58	0.57	0.64	0.60	0.73

All correlation coefficient were significant at the level $\alpha = 0.05$

The above table shows that the correlation coefficient value between the total score for the scale and Jibreel’s [18] math basic

skills diagnosis scale is (0.73) which is acceptable for the purposes of availability of construct validity of the scale, construct

validity for different areas' scores for the scale of this study and Jibreel's math basic skills diagnosis scale between (0.56) for the fractions area and (0.72) for geometry and measurement area.

Also, it shows that construct validity coefficients for the scores of different areas of Jibreel's math basic skills diagnosing scale and math learning disability diagnosing scale were all statistically significant at the level ($\alpha=0.05$) which verifies the validity of the scale of the study.

The researchers ascribe these results to following the main steps to verify the content validity, in addition to using large and enough number of test questions for each difficulty of most common learning disabilities to obtain the reliable ones, in addition to selecting the representative sample of the study and subject it to same circumstances in both tests, which had a great impact in obtaining true results of the test. Therefore, the results of this study, linked to validity indicators, agree with many studies; such as Jibreel [18] which indicated that the scale had content validity

indicators on Jordanian sample by calculating referees' consensus rate and construct validity indicators by calculating correlation coefficients with Alwaqfi's scale [10]. Also, the current study agrees with Althbaiti's study [16] in terms of scale's psychometric characteristics.

Results related to the second question:

What are the achieved reliability indicators for math learning disabilities diagnosis test among fourth grade students?

Scale's reliability indicators were achieved by the following:

Test and Retest method: scale's reliability indicators were achieved by calculating the correlation coefficients between examinees scores in the first and the second implementations, retest has been made on a sample of (75%) students, after two weeks of applying the main test. Reliability coefficient was extracted by Pearson method, table (2) shows the results of calculating reliability coefficient for each area of scale's areas and the total score.

Table (2) Reliability Coefficients of Scale's Areas and the Total Score by Retest

Area	Coefficient
Concept of Numbers	0.912
Fractions	0.907
Operations on numbers	0.903
Geometry and Measurement	0.883
Total Score	0.917

Table (2) shows that the highest correlation coefficients between the first and second implementations on scale's areas was on the area "concept of numbers" (0.912), least correlation coefficient was on "geometry and measurement" (0.883), correlation coefficient for total score (0.917), which reflect high degree of score stability between the first and the second

implementations, which indicates that the scale somehow has adequate reliability indicator at the level (0.01).

Cronbach's Alpha: Cronbach's alpha correlation was calculated for all the sample of the study consisted of (1080) students, table (3) shows the reliability coefficients for the four areas of the scale, and for the scale as a whole.

Table (3) Reliability Coefficients for Scale's Four Areas and for the Scale as a Whole for the Three Grades

Area	Correlation Coefficient
Concepts of numbers	0.926
Fractions	0.931
Operations on numbers	0.914
Geometry and measurement	0.919
Total score	0.938

Table (3) shows that reliability coefficient value for the scale as a whole was (0.938), reliability coefficients for scale's areas ranged between (0.914

The researchers ascribe these results to identifying the difficulties to be measured, including it within the tests, correct identifying for the areas to be tested, and subject all the test for all circumstances which contributed to the measurement of the same feature by all tests, and to measure what it supposed to measure. It also could be ascribed to the ambiguity-free questions which hinder the correct understanding, therefore, answers were approximate which lead to increase the reliability coefficient. In the light of these findings we find that the reliability coefficients by the three methods were more than (0.90) which agrees with Jibreel [18] study, Althbiti [16] study, Mujahidi

– 0.931), which indicates that the scale has adequate reliability indicator according to this method.

and Jallad [15] study in terms of scale's psychometric characteristics.

Results related to the third question:

What is the effectiveness of the paragraphs composing math learning disability diagnosis test among fourth grade students? To identify the paragraphs ability in discrimination, discrimination coefficients were calculated for each paragraph of the scale by studying the correlative relationship between the performances on the paragraph with each of the score of the area it belongs to and the total score, as shown in table (4):

Table (4) Correlation Coefficients between the Paragraph and its Area's Score and the Total Score

Area	Paragraph Number	Correlation Coefficient with the Area	Correlation Coefficient with Total Score	Paragraph Number	Correlation Coefficient with the Area	Correlation Coefficient with Total Score
Concepts of Numbers	1	0.87	0.88	2	0.91	0.86
	3	0.59	0.57	4	0.75	0.73
	5	0.66	0.63	6	0.61	0.53
	7	0.38	0.40	8	0.82	0.78
	9	0.64	0.57	10	0.63	0.59
	11	0.53	0.48	12	0.55	0.47
Fractions	13	0.57	0.55	14	0.65	0.61
	15	0.65	0.61	16	0.69	0.67
	17	0.61	0.60	18	0.75	0.74
	19	0.85	0.82	20	0.71	0.67
	21	0.61	0.54	22	0.62	0.59
	23	0.69	0.66	24	0.57	0.52
Operations on Numbers	25	0.40	0.36	26	0.71	0.73
	27	0.65	0.67	28	0.63	0.58
	29	0.42	0.35	30	0.55	0.52
	31	0.47	0.44	32	0.61	0.57
	33	0.63	0.59	34	0.41	0.39
	35	0.59	0.57	36	0.45	0.40
Geometry and Measurement	37	0.47	0.46	38	0.64	0.60
	39	0.66	0.65	40	0.64	0.60
	41	0.75	0.72	42	0.75	0.77
	43	0.61	0.55	44	0.58	0.47
	45	0.55	0.50	46	0.40	0.36

Table (4) shows that correlation coefficients between the performance on each paragraph and its area ranged between (0.38-0.91), values of these coefficients between the performance on each paragraph and class scale as a whole ranged between (0.35-0.88), all these coefficients were statistical significant at

level lower than (0.05) by using SYSTAT statistical software to analyze the output data of this scale, in which all of that indicate the extent of coherence and interaction for the paragraphs composing this scale. Correlative coefficients of each paragraph with the total score of the scale were coherence and of statistical

significance which assure true belonging of these paragraphs to the scale, in which high correlation between each area and the

These results may be ascribed to the selection of paragraphs which suit each area of the study, in addition to the availability of information and data needed to study the problem, the researchers also ascribe these findings to the selection of different types of paragraphs with difficulties adequate to students' different abilities; some was easy, medium difficulty, and hard, in addition to reviewing the test by specialists who contributed greatly to the revision of the paragraphs and modifying them to correspond to each area to which it belongs.

Because of the objective type of the test questions which gave it high reliability and validity indicators because it cover many areas of learning disabilities and make it possible to determine math difficulties that the student suffer from, which helps in diagnosing these difficulties in students' math learning.

The results of this study, regarding the effectiveness of the paragraphs of the four areas, agrees with Jibreel [18] study with high correlation coefficients of paragraphs with total score regarding the four areas, also, it agrees with Mujahidi and Jallab [15] study, in terms of the paragraph's effectiveness by paragraphs analysis method.

Conclusion:

From the previous findings, which showed that the psychometric characteristics of the scale are controlled, the main question of the study can be answered: Is it possible to develop a scale to diagnose math learning disabilities among fourth grade students?

Math learning disabilities diagnosis test has adequate validity and reliability indicators, and correlation coefficients between each item's performance and the

scale proves that the feature measured by the scale in any area is what the scale measure in general.

area it belongs to, therefore, the test is adequate for the purpose it was made for.

Recommendations:

Based on the current study findings, the researchers recommend:

- To shed light on students who suffer from learning disabilities in math.
- To perform periodic surveys among students in basic stage for early detection of learning disabilities.
- To inform school's administrations and the families on the diagnosis results.

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