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The Effectiveness of a Program Based on Brain-Based Learning in Acquiring Mathematical Skills among Students with Learning Difficulties in Math

By

Sokaina S. AlAkayleh
Curricula & Instruction Dept., Yarmouk University, Jordan
Email: akailahsukaina@gmail.com

Prof. Ali M. Al-Zoubi
Curricula & Instruction Dept., Yarmouk University, Jordan
Email: Ali.m@yu.edu.jo

Abstract

This study aimed to investigate the effectiveness of a brain-based learning program in improving mathematical skills among students with learning difficulties in mathematics. The program consisted of 16 training sessions. The research used a semi-experimental design. In order to achieve this aim, the researcher developed a math skills test. The population of the study consisted of all students with difficulties in learning mathematics in grades four-six who are enrolled in the learning resource rooms in the schools of the Directorate of Education in the Markka district in the second semester of the academic year 2022/2023. 50 students participated in the study, they were divided into two groups (experimental group = 26 ،control group = 24). The results revealed the effectiveness of a brain-based learning program in acquiring mathematical skills for students with learning difficulties.

Introduction

Background of the study

Mathematics is a complex field of knowledge for learners due to its cumulative nature, abstraction, and diverse subject matters. Learning mathematics brings many difficulties for students, and these difficulties are among the most important and common learning difficulties. The nature of mathematics agrees with human beings and their thinking, as they love order, classification, and organization. Learning mathematics is an important requirement and essential necessity to meet their needs in understanding time, space, measurement, and to distinguish between mathematics, its skills, and the reality of life and its problems is a main reason for drifting away from the natural context in which it originated and for which it is necessary. Mathematical skills are one of the large set of important experiences in a child's life, and their importance lies in being a primary tool for organizing and understanding ideas and the surrounding environment, and a gateway to solving everyday life problems. Furthermore, mathematical concepts are the basic building blocks upon which logical thinking is built. Therefore, it is necessary to strive to build mathematical experiences and skills in the elementary education stage, due to the impact of these experiences on their progress in the subsequent secondary and high school stages (Al-Tarawneh, 2012).

the rapid developments and changes taking place in our country are nothing but the product of the thought of the human mind, and what is happening now in terms of developments in the era of technology in which human knowledge multiplies and ideas flow in a rapid and remarkable manner, but this massive explosion of information forced the human forces to repel

what they encounter problems, so we have to do more mental operations to solve them, discoveries by educators, physiologists, physicians, anatomists, and psychologists in the mechanism of the human mind and the understanding of learning methods have caught the attention of interested parties. This has a significant impact on laying the groundwork for understanding the biological foundations of behavior in general and knowledge in particular, by recognizing the functions of the brain, glands, senses, and other organs and how they operate. This, in turn, leads to the necessity of understanding learning methods, which requires some knowledge of how the brain works, how it learns, and how to take advantage of its functions. Furthermore, individuals' emotions and backgrounds differ, so each person acquires and learns information in different ways. Therefore, learning methods for individuals should be identified based on the brain's methods of operation and its functions. Accordingly, the content, design, and presentation of all learning activities should be diversified to suit the various learning methods of students (Abdulqader, 2014).

Despite the developments and changes that have taken place in mathematics curricula, there is a need to assess teachers' knowledge of modern teaching methods and their use, such as brain-based learning. Teaching mathematics requires continuous brain activity in the classroom, and often, the teaching of mathematics involves presenting examples and solving them by the teacher, with the role of the learner being passive. This does not suit modern trends in teaching mathematics. To build sound mental habits that make the learner a thinker and critic, and to make the learning and teaching process easy and acceptable to them, it is necessary to diagnose and evaluate the reality of mathematics curricula and their suitability for modern learning principles such as brain-based learning (Asiri, 2002).

Based on the above, Sousa, (2017) prepared and adjusted a teaching strategy based on brain-based learning, which consists of five stages:

Preparation and readiness for learning

A comprehensive learning framework must be provided, and the student's brain must be equipped with the necessary connections, including a general and clear idea of the subject as well as a mental visualization of mathematical topics.

Acquisition

The sources of acquisition include, discussion and dialogue, environmental stimuli, visual tools, role-playing, and group projects, as this stage in forming connections is essential and heavily reliant on previous experiences.

Elaboration

This stage reveals clear connections in mathematical topics and supports students with mathematical skills. Therefore, students are involved in classroom activities and tasks to better understand mathematical skills, and appropriate feedback is provided for students' responses.

Memory Formation

This stage aims to strengthen the learning process and facilitate better information retrieval, as there are other factors that help achieve durable learning and easy retrieval, including emotional intensity, sufficient rest, prior learning, type, and quantity of connections.

Functional Integration

This stage focuses on employing new learning to further enhance it. Thus, the new learning becomes deep, robust, and easy due to the vast branching neural connections between nerve cells.

Therefore, the current study aims to investigate the effectiveness of a brain-based learning program in improving mathematical skills among students with learning difficulties in mathematics.

Statement of the problem

Although mathematics has a crucial and significant impact on individuals' and groups' lives, the reality indicates that there is a clear weakness in acquiring its skills for students with learning difficulties. Through studies and the opinions of many teachers, many students with learning difficulties do not possess a sufficient level of mathematical skills and barely know the primary skills such as addition, subtraction, division, and multiplication by the end of elementary school. This weakness may lead them to drop out of school and turn to professional and manual work (Hussein, 2015).

The previous text supports the necessity of conducting a study and searching in this field. The researcher - based on her experience in teaching mathematics - believes that the reasons for this weakness may be attributed to the continuation of the traditional approach in teaching mathematics and the lack of using modern strategies that increase students' motivation towards learning and make them practice mathematical skills functionally in their daily lives.

Therefore, the study has focused on brain-based learning strategy as an educational strategy that may help improve students' mathematical skills. This is the aim of this study, and due to the lack of studies that have addressed students with learning difficulties in mathematics and the various educational strategies for them, within the limits of the researcher's knowledge, many studies have focused on reading difficulties more than studies that addressed mathematics difficulties. The researcher believes that trying this program may be beneficial in knowing its effectiveness in developing mathematical skills among students with learning difficulties.

Purpose and questions of the study

The present study aims to investigate the effectiveness of a brain-based learning program in improving mathematical skills among students with learning difficulties in mathematics. It seeks to answer the following research question "What is the effectiveness of a brain-based learning program in acquiring mathematical skills among students with learning difficulties?"

Significance of the study

The importance of studying lies in its potential to assist teachers who teach students with difficulties in learning mathematics and help curriculum developers to benefit from the proposed program, its objectives, educational strategies, and enrichment activities When planning educational programs. This study may make students aware of the importance of mathematics skills and the effects of mathematics anxiety on students.

The Limitations of the study

This study was limited to fourth, fifth, and sixth-grade students in resource rooms at two schools within the Education Directorate of Markka in the academic year (2022-2023).also, the study tools were prepared by the researcher, and the results may be affected by their validity and reliability.

Operational definition of terms

Brain Based Learning theory is defined by Zaytoun (2001:12) as "a theory that is based on the structure and function of the brain, and emphasizes a deep understanding of the brain

and its complex functions, and adopts more effective methods for the processes of teaching and learning." It involves learning with the mind, with high stimulation, realism, fun, excitement, cooperation, absence of threat, and the interaction and integration of various systems in the learning process (Jensen, 2000). In this study, it can be defined as the organization of educational situations and learning experiences according to the structure, processes, and nature of the brain. Teachers can be trained in this theory to acquire teaching skills that make their performance effective in these situations.

The Brain-Based Program: In this study, it can be defined as a set of training activities, procedures, and teaching practices with specific goals based on brain-based learning principles. The program aims to meet the requirements and characteristics of the brain, leading to the activation of both hemispheres of the brain and their integration. Therefore, it contributes to the learning and teaching of mathematics for students with learning difficulties in mathematics.

Students with learning difficulties are: "an individual whose level of achievement in mathematics is significantly lower than their peers, and this is not due to hearing, visual, or intellectual impairments" (Eichhorn, 2016, :77). In this study, it can be defined as students who struggle with learning mathematical skills and have low academic achievement in schools under the education directorate of Markka region.

Difficulties in learning mathematical skills:" is a term that refers to difficulties in using and understanding mathematical concepts and facts, numerical and mathematical reasoning, performing and processing mathematical and arithmetic operations. These difficulties are manifested through the inability to comprehend mathematical concepts and the difficulty in performing arithmetic operations." (Al-Zayyat, 2002: 548). It is measured procedurally by the grade that the student will achieve in the test used in the study.

Theoretical background

It is noteworthy that brain-based education focuses on stimulating students' motivation, emotions, and attitudes towards learning mathematics. It also emphasizes the prerequisite requirements necessary for new learning, so that learners connect their previous experiences to new learning topics. Consequently, active processes and procedures are used through brain processes. It is important in this strategy to reduce math anxiety and increase student motivation to learn (2006, Shields).

The concept of brain-based learning differs in educational literature, as some consider it a theory that explains the workings of the human brain, while others view it as a strategy that uses findings from neuroscience research. Still others consider it techniques and strategies derived from cognitive neuroscience research, and have been employed to support teacher performance and enhance learner capability. Al-Mutairfi (2014:152) defined it as "employing strategies based on principles or rules derived from an understanding of how the brain works." Jensen (2014:18) defined brain-based learning as" a comprehensive approach or entry point to the processes of teaching and learning based on modern neuroscience assumptions that explain the natural development of the brain. This type of learning is considered learning according to the way the human brain is naturally wired to learn."

Scientific research over the past fifteen years has revealed many secrets about the brain, and this information has led to amazing changes in how it can be used in the process of education and learning more effectively, quickly, and easily. Educational trends have called

for a reexamination of the content, objectives, methods, and strategies of the educational process, allowing students to acquire knowledge based on the brain. (Abu Rayash & Abdulhak, 2007).

The cognitive revolution, represented by the application of brain research to the processes of learning and education, will change the start of the school day, disciplinary systems, evaluation methods, teaching strategies, budget priorities, and the educational environment. It will also affect the use of technology and even the way we view physical and artistic education. (Jensen, 2001)

The brain-based learning theory requires certain specifications for the structure of learning, such as being active and designing study rooms to be rich in stimuli, providing a collaborative atmosphere, and creating a challenging learning environment with a meaningful purpose. The justification for the importance of brain-based learning theory, as stated by Qutami and Al-Mashaalah (2007), is that it is a strategy for increasing student productivity and reducing teacher frustration. In this theory, the brain learns naturally, and the teacher is given the opportunity to apply better learning and open the door to unlimited possibilities in the classroom. In traditional education, teachers transfer information to students, and students are evaluated based on the amount of information they have stored. Is this the type of education we want? Does this education serve the students' interests? Many brain research studies support the criticisms of education and also support some previous knowledge. They help teachers push the wheel of change in the field of education, especially for the benefit of students and society, to align education with current and future requirements.

The previous literature has highlighted several characteristics of brain-based learning strategies. Both Rehman et al,. (2012) and Soonthornrojana (2007) have emphasized that it is a system in itself and not a pre-designed model with absolute instructions. It is a multidisciplinary approach derived from various systems of psychology, genetics, chemistry, biology, and computer science. The motivation for learning is internal, and learning is continuous, with direct and constant feedback. It is a natural, supportive, and positive way to increase the ability to learn, and it relies on the specifications and nature of the brain in making decisions and learning. Collaboration and effectiveness are essential, and the learning environment is a stimulating and rich environment with positive emotions, based on attention and memory.

It is worth noting that there are many factors that influence brain-based learning. The learner does not come to school as a blank slate, but rather comes with many experiences acquired in their early years. The learner's brain has been shaped by multiple influences, but the most effective use of these influences to make brain-based learning meaningful and effective requires knowledge of the factors that influence brain-based learning. Some of the most important of these factors include:

Firstly, "A conducive learning environment" refers to an environment that is capable of meeting the growth demands of a better brain. Studies have shown the impact of well-prepared and rich environments in making learning more effective, such as the study by Bay-Hintz et al. (2000) and Mayo-Waltkins & Samuel (1999), which tested the factors that improve brain-based learning. They came to two things that are of particular importance in developing better brain learning. The critical elements in any program aimed at enriching the learner's brain are: learning should be challenging with the presentation of new information or experiences, as seriousness and challenge often lead to the desired outcome. Also, there should be some way to learn from experience through interactive feedback.

Secondly: Capturing Attention: The process of attention involves alerting, orienting, selecting, and deciding, and this sequential process is similar to the situation "something is happening" then "where?" and finally "what is it?" The answer to the last question usually tells us how long we should pay attention to it. Learning occurs when there is a greater flow of information in the target area of the brain's pathway compared to the surrounding pathways. In short, when specialized activity occurs in the brain, attention is drawn. Generally, brain performance is low during periods of sustained intense attention, and true attention can remain high and steady for a short period of up to 10 minutes or less inside the classroom (Barbara, 2002). There are three reasons why continuous attention is unproductive, as (Jensen, 2001:85) mentioned "(1) Much of what we learn cannot be processed perceptually because it happens too quickly and we need time to process it. (2) In order to form new meaning, we need time because meaning is always generated from within and not from outside. (3) After each new learning experience, we need time to consolidate the learning".

Thirdly: Stress and relaxation: When a person feels stressed, the adrenal glands release a peptide, and our bodies respond to the secretions of the adrenal gland whether the person is facing physical, environmental, academic, or emotional danger. This leads to a series of physical reactions. As stress is a part of the life cycle, stress and relaxation must be balanced if I want the brain to function properly. If a person is exposed to more stress and is deprived of relaxation for a very long time, he or she cannot adapt (Clark, 2004).

Fourthly: Motivation, despite most teachers categorizing students into motivated and unmotivated, the reality is quite different. Most students have an internal motivation, but it depends heavily on the circumstances and context. We notice that some students who may seem unmotivated and indifferent in a math class can be very lively and active when calculating sales while working in a commercial store (Pinkerton, 2002).

Fifthly, emotions have an impact on a learner's behavior because they create distinct physical and mental states. An emotional state is defined as a specific psychological or mental state that involves rapid breathing and a chemical balance in the body resulting from glandular secretions. These secretions have a dramatic effect on both mental and physical states, as they are released from areas such as the spinal cord, adrenal glands, and nerve fibers in the brain, allowing emotional chemicals to influence most of our behavior (Afana & Aljeshi, 2009).

Sixthly: Movement: One of the most surprising observations made by brain researchers is that physical movement is crucial for learning. Certain types of bodily movement can stimulate the natural release of chemicals in the body that awaken the learner, increase their energy levels, improve their ability to store and retrieve information, and help them feel good. If we want to improve student learning, we must recognize the importance of movement and purposeful changes in location, position, or stance as part of the learning process (Clark, 2004). Brain-based learning enables educators to integrate mathematics, movement, geography, social skills, role-playing, science, and physical education together. Therefore, according to brain-based learning theory, learning can be distinguished into two types: (Mohammed, 2011).

As for the role of the teacher in brain-based learning, it involves identifying the learning patterns and individual learning styles of each student, creating a suitable classroom climate that aligns with cooperative work, providing opportunities for students to analyze, synthesize, and employ dialogue, discussion, and teamwork. The teacher also presents verbal and visual information together, allowing for the formation of mental images of perceptions. The teacher provides opportunities for students to remain mentally alert and engage in brainstorming, while providing challenging intellectual tasks that form desired interests and attitudes towards

academic subjects, thereby increasing their interest in solving scientific and social problems that align with their capabilities. Additionally, the teacher provides educational activities and experiences that stimulate students inside and outside the classroom environment. (Abid & Afana, 2003).

Just as there was a need to call for a learning approach that places the learner at the center of the educational process, this necessity is a sufficient reason to use brain-based learning strategies in teaching mathematics to students with learning difficulties, which help them develop and organize the learning process and manage it in a way that ensures progress towards the goal. The use of brain-based learning strategies in mathematics focuses on activating all components and types of thinking in the learner in order to stimulate and excite the brain to work. It makes the learner the main axis of learning, where he/she is considered the planner, executor, evaluator, and teacher himself/herself. It provides the learner with future goals and aspirations that may make him/her feel that he/she has a great brain that may enable him\ her to acquire mathematical skills, which are the backbone of learning mathematics for students with learning difficulties (Afnanah & Al-Jayyoushi, 2009).

The mathematics curriculum and its various skills are essential for forming a mathematically thinking learner by developing a wide range of mathematical skills and enhancing their abilities to solve problems, logical-mathematical thinking, and justification skills. The curriculum also plays an important role in presenting mathematical skills in an engaging and enjoyable way that makes students feel the importance of their role as the main axis of the learning and teaching process. It encourages them to understand and form the concepts they learn rather than just increasing their knowledge quantity. So, mathematical skills have a special significance as their environment offers students opportunities to immerse themselves in the thinking process (Turner & Rossman, 1997).

Mathematical skills can be defined as the ability of learners to handle mathematical operations using correct scientific methods and performing them in a fully integrated mathematical process characterized by accuracy, speed, and ease with minimal effort and time (Al-Shabatat, 2017). As defined by Afana et al. (2012, 120), "skill is the action that an individual demonstrates in a practical way correctly, quickly, and proficiently when facing a situation that requires work to solve a specific problem. This requires a precise and comprehensive understanding of the regular relationships in the situation, knowing how, when, where, and why to take such action in similar situations."

Although mathematics has a crucial and significant impact on individuals and groups' lives, the reality indicates that there is a clear weakness in acquiring its skills for students with learning difficulties. Through studies and the opinions of many teachers, many students with learning difficulties do not possess the sufficient level of mathematical skills and barely know the primary skills such as addition, subtraction, division, and multiplication by the end of elementary school. This weakness may lead them to drop out of school and turn to professional and manual work (Hussein, 2015).

It is observed that most of the reasons for the low academic achievement in mathematics among elementary school students are primarily due to weakness in basic mathematical skills. The weakness in mathematical skills among students has multiple causes, including those related to the student himself, such as the student suffering from health, psychological, or social problems that prevent him from mastering mathematical skills. There are also causes related to the teacher and teaching strategies used, as evidenced by teachers who neglect training and

practice and do not consider scheduling training. Additionally, not considering individual differences among students leads to the accumulation of weakness in some students.

One of the reasons that may lead to students' weakness in mathematical skills is the overwhelming and inadequate nature of the curricula, which may have a negative impact. Additionally, the short duration of class time leads to a lack of sufficient time for practicing the skill, resulting in weakness among a wide segment of students in these skills. Alkhatib (2011) mentioned several reasons that generally lead to students' weakness in acquiring mathematical skills, including: insufficient time for practicing the skills, inadequate understanding of mathematical concepts and generalizations on which the skill is based, technological developments and the emergence of computers have led to a lack of interest by some learners in acquiring mathematical skills, ineffective methods in teaching mathematical skills, lack of fun and motivation for learners towards mathematics, weakness in the ability of students to deal with abstract ideas and symbols, and lack of interest in completing the necessary mathematical competencies.

Scientists and researchers explained that the best solution to address the problem of poor acquisition of mathematical skills among students with learning difficulties is through training, practice, cognitive development, and accumulation of experiences. Therefore, the development of mathematical skills does not happen by chance but rather requires learners to be exposed to purposeful and diverse educational situations and activities that develop their mathematical thinking skills at different levels (Yalçınkaya, 1998).

Afana et al,. (2012) explained several proposals followed by the teacher for a proper development of skills, including: developing understanding before skills, as it is acknowledged that a student's performance in carrying out a skill improves if there is comprehension of what they are doing, and this is always better than memorizing rigid rules and applying them without awareness or understanding; encouraging original thinking, as the teacher should motivate students to think of new solutions and innovate methods themselves, and not force them to solve problems in a certain way, since building skills should allow for multiple paths of thinking; training should focus on correct procedures and solutions, not incorrect ones, which requires tracking the students' mistakes and working on correcting them immediately; training should be tailored to students' abilities and preparedness, and individual training needs should be considered; training should be spaced out over time; students should be given guidance and direction, and should be provided with a measure of their progress. Finally, enthusiasm and motivation for learning should be aroused through encouragement, diversity, psychological support, and proper guidance.

In order to achieve better learning and mastery of mathematical skills, the teacher must plan well and consider some important principles, including the skill must meet the needs of the student and provide them with a desire to learn; focus on developing the skill itself; work to change the learner's behavior to improve learning outcomes and accurately measure them; logical sequencing of skills, starting from simple to complex; the skill should be linked to a life-related educational activity and not be taught separately; scheduling training so that the skill is not forgotten over time; good and accurate planning for teaching the skill, using all appropriate means and methods, and considering individual differences among students; and involving students in planning and organizing their learning (Al-Khatib, 2011).

Mathematical skills are considered to be the core of the mathematics subject. After students grasp the initial concepts related to the structure of numbers and the relationships between them, they develop mathematical skills on these numbers through training, simulation,

imitation, continuous feedback, and reinforcement, to practice mathematical thinking, induction, and deduction. The role of the teacher is highlighted in the importance of employing modern and diverse strategies to make these skills a part of their daily skills (Qattash, 2019).

Review of the Related Literature

Olofin and Olojo (2022) conducted a study aimed at investigating the effect of brain-based strategy on developing math skills among secondary school students in Ekiti state, Nigeria. A quasi-experimental design was adopted for the pre-test and post-test. The study population consisted of all students in the three public secondary schools in Ekiti Country. The sample comprised 181 students. The results showed that the brain-based strategy was more effective and reliable than the traditional method in enhancing math skills and improving students' performance.

Amelia et al., (2022) did a study which aimed at determining the effect of brain-based learning strategy on the development of mathematical communication skills. A quasi-experimental method was adopted to design the pretest and posttest. The study sample consisted of 173 fifth-grade students from Pangadegan village, south of Jakarta. The researcher used a test for mathematical communication skills as a tool for the study. The results revealed that the mathematical communication skills of the experimental group in mathematics significantly increased compared to the control group. Therefore, brain-based learning strategy has a positive effect on mathematical communication skills in learning mathematics.

Altarawneh (2020) carried out a study aimed at investigating the effect of a brain-based learning training program on improving spatial mathematical skills. The study sample consisted of 60 ninth-grade students in Al-Karak governorate, Jordan. To achieve the study objectives, a training program based on brain-based learning was developed. The results showed that the training program led to an improvement in spatial ability and its three components in the experimental group compared to the control group.

Vihokpaibul (2020) conducted a study aimed at developing brain-based learning materials and mathematical learning skills for elementary students (grades 1-3) according to learning indicators and standards for mathematics curricula (2017 version). The study sample consisted of 50 students who were studying in the fourth year of the mathematics program in schools located in the remote area of Ban Na, Nakhon Nayok Province. The results showed that the evaluation of the efficiency of brain-based mathematics learning materials for elementary students was very high. The results also showed the development of mathematical skills in three areas: numerical thinking, problem-solving, and students' intelligence in grades 1-3 according to learning indicators and standards.

ElAdl (2020) did a study aimed at identifying the impact of a brain-based learning program on developing mathematical skills and scientific thinking among students with math learning difficulties. The program consisted of 22 training sessions. The researcher used a quasi-experimental design. The study sample consisted of 71 students in Oman, divided into two groups: a control group of 36 participants (16 males and 20 females) and an experimental group of 35 participants (16 males and 19 females), both with an average age of 13 years. The results indicated statistically significant differences in the mathematical skills test in favor of the experimental group.

Mohammed (2019) conducted a study which aimed to verify the effectiveness of a program based on brain-based learning theory in developing both attention and perception

skills among children with learning difficulties in mathematics. The study sample consisted of 38 boys and girls from the third grade of primary school with learning difficulties in Alexandria. The researcher used an experimental method, and a set of tools, tests, and measures were used to detect early developmental math learning difficulties in children. The study concluded that the mathematical cognitive skills of the experimental group of children improved after the application of the training program for children with learning difficulties.

Bahrun, Zubainur & Triana. (2019) carried out a study aimed at analyzing the development of students' mathematical communication skills using a brain-based learning approach. Twenty-eight tenth-grade students from a high school in Banda Aceh participated in the study. Two instruments were used to collect data: a mathematical communication skills test and activity monitoring. Data were analyzed using descriptive analysis. The study showed that learning mathematics using a brain-based learning approach contributes to the development of students' mathematical communication skills.

Al-onizat and Al-Qatawneh, (2019) conducted a study aimed at verifying the effectiveness of an educational program based on brain-based learning theory in improving mathematical skills and motivation among students with learning difficulties. The sample of the study consisted of 60 male and female students with learning difficulties in the third, fourth, and fifth grades. The sample was randomly divided into two groups: an experimental group and a control group. To achieve the study's objectives, the researchers developed three tests. The results indicated statistically significant differences in favor of the experimental group in the post-test of mathematical skills and their sub-dimensions.

Methods and procedures

This section elucidates the design, Population of the Study, participants, and instruments, along with their reliability, validity, data analysis, and procedures are also presented in this section.

Population of the Study

The study population consisted of all students with difficulties in learning mathematics in grades four to six who are enrolled in the learning resource rooms in the schools of the Directorate of Education in the Markka district in the second semester of the academic year 2022/2023.

Sample of the study

The study sample was selected using purposive sampling from two schools in the education directorate of Markka, where students from Jumana school represented the experimental group, which was taught using the brain-based learning method, and consisted of 26 students, while students from Al-Khansa Elementary School for Girls represented the control group, which was taught using the traditional method and consisted of 24 students.

Instrument of the study

Math skills test: the researcher developed a math skills test that includes skills such as reading numbers up to 9999, writing numbers up to 9999, identifying the place value in a four-digit number, comparing numbers up to 9999, ordering numbers up to 9999, adding and subtracting numbers up to 9999, recognizing angles and their elements, naming and drawing them, understanding multiplication facts up to 9x9, and measuring a straight piece in centimeters. This test aimed to measure the level of students' skills before starting the program

and after its implementation. This test was prepared from a set of "multiple-choice and essay items" to measure the aforementioned math skills.

Validity of the test

The face validity of the test has been verified using expert judgment, where the test was distributed to 10 members of the teaching staff who specialize in curriculum and teaching methods in Jordanian universities, as well as mathematics supervisors. An agreement rate of 95% was determined among the judges.

The difficulty and discrimination coefficients

The difficulty and discrimination indices for the test items were verified on a sample of 34 male and female students from a study section at Amoria Elementary School. The discrimination coefficient between the items was then extracted and shown in Table (1).

Table (1): *Discrimination and difficulty coefficients for the test items*

#	Discrimination coefficients	Difficulty coefficients	#	Discrimination coefficients	Difficulty coefficients
1	.448	.32	7	.422	.41
2	.448	.32	8	.400	.35
3	.485	.38	9	.392	.47
4	.516	.32	10	.448	.32
5	.421	.35	11	.486	.41
6	.470	.32	12	.434	.47

Table (1) shows that the difficulty coefficients for the test items ranged from (0.32-0.47) and the discrimination coefficients ranged from (0.392-0.516). These discrimination coefficients and difficulty coefficients are considered suitable according to the Ebel criteria referred to in (Al-Nabhan, 2004). All test items have been adopted, indicating the appropriateness of the test items for conducting the test.

Reliability of the test

Test-retest reliability was verified by administering the test to a sample of 34 students and recording their scores. The test was then administered again after a 14-day interval, and the students' scores were recorded. The correlation coefficient between the students' scores on the two administrations was calculated to be 0.85, indicating a high degree of correlation. Additionally, internal consistency reliability was assessed using Cronbach's alpha and yielded a coefficient of 0.80, which is considered good for this type of test and indicates that the test has an appropriate level of reliability.

Test correction

The test will consist of (5) multiple-choice questions with (8) items in each question, and one mark will be allocated for each item in this question. The remaining (4) questions will be essay-type questions with (3) marks allocated for each question, totaling (12) marks. Therefore, the maximum score for the test is (20) and the minimum score is zero.

The Findings and Discussion

Results related to the research question: "What is the effectiveness of a brain-based learning program in acquiring mathematical skills among students with learning difficulties?" To answer this question, means and standard deviations were calculated for the overall

performance of the two study groups on the pre- and post-application math skills tests, and Table (2) shows the results.

Table(2): *means and standard deviations of the total score of the performance of the two study groups on the mathematical skills test, pre and post-learning, and average for students with difficulties*

Group	N	Total score	Pre- test		Post-test		adjusted	
			mean	df	Mean	df	Mean	standard error
Experimental	26		5.23	1.56	11.08	2.06	10.62	0.235
Control	24	20	4.1667	1.34	5.13	1.29	5.61	0.245
Total	50		4.72	1.54	8.22	3.46		

Table (2) shows the presence of differences in the performance of the two study groups on the mathematics skills test among students with dimensional learning difficulties. The mean score for the experimental group was 11.08 and the mean score for the control group was 5.13. To ensure that the difference between the two means is statistically significant, One Way ANCOVA analysis was used, and the results are shown in Table (3).

Table (3): *One-Way ANCOVA for the difference between the two means of the total score for the performance of the two study groups on the post-mathematical skills tests for students with learning disabilities.*

source of variation	Sum square	df	Mean Squared	f	sig	Eta squred
Pre-test	81.296	1	81.296	60.481	.000	.563
Teaching method	274.204	1	274.204	203.997	.000	.813
Error	63.175	47	1.344			
Total	3965.000	50				
Corrected total	586.580	49				

The table (3) shows a statistically significant difference between the mean total scores of the two study groups' performance on the spatial mathematical skills test, based on the calculated value of (F) which was (203.997), and with a significance level of (0.000). The experimental group had a higher mean score of (10.62) compared to the control group's lower mean score of (5.61). The effect size was (0.813), which means that the program accounted for (81.3%) of the total variance in the improvement of mathematical skills among students with learning difficulties. According to Cohen, this effect size is considered large, indicating the effectiveness of a brain-based learning program in acquiring mathematical skills among students with learning difficulties. This means that the remaining percentage, which is (18.7%), can be attributed to other unexplored factors in the current study.

As previously mentioned, the results have shown the effectiveness of a brain-based learning program in acquiring mathematical skills for students with learning difficulties, this result is in correlation with (Olofin and Olojo, 2022) ؛ (Altarawneh, 2020) ؛ (ElAdl, 2020) ؛ (Mohamed, 2019) ؛ and (Bahrun, Zubainur and Triana, 2019).

This can be attributed to the program's use of active learning techniques and strategies (such as self-questioning and cooperative learning) and identifying individual thinking and learning patterns for each student to provide a customized learning environment tailored to

their individual needs. Children with learning difficulties may have difficulty understanding mathematical concepts due to their inability to concentrate properly or their inability to learn in the same traditional way used in schools. Through the use of brain-based learning techniques, the brain can be stimulated and its cognitive functions can be improved, thus improving the student's ability to understand mathematical concepts. The brain-based program may have also contributed to improving the memory, focus, and attention of the experimental group, which are essential skills for acquiring mathematical skills.

The result can be attributed to the fact that the brain-based learning program provided many enrichment activities that helped students with learning difficulties develop some mathematical skills and provided numerous opportunities for thinking and expression without shame or fear and trying to experiment and solve problems repeatedly. The program also included several strategies such as mind mapping, the five-stage learning cycle, and self-questioning. These constructive learning strategies based on inquiry in teaching program topics have helped students with learning difficulties improve their acquisition of mathematical skills such as questioning and problem-solving through the enrichment activities and topics presented by the program.

In addition to the above, this result can be attributed to the fact that the brain-based learning program included many teaching materials and worksheets that helped students acquire mathematical skills by participating in executing and solving worksheets and applying what they learned in multiple situations, which provided them with many opportunities to practice those skills and included questioning and problem-solving using more than one sense.

Furthermore, the brain-based learning program included constructive assessment methods after each section, which helped students learn from their mistakes, and the teachers provided them with feedback after each part of the topic, thus helping them overcome their failures in some topics and training them on those skills.

Recommendations

Based on the results obtained, the study recommends a set of recommendations and proposals:

1. Conduct training courses for learning difficulties teachers to train them on designing and implementing lessons using brain-based learning.
2. Raise awareness of the importance of using brain-based learning in the educational process and in developing mathematical skills and reducing anxiety levels about the subject.
3. Conduct further future studies using brain-based learning to improve academic achievement and develop self-efficacy among students with learning difficulties.

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