# EFFECTIVENESS OF A BRAIN-BASED LEARNING THEORY IN DEVELOPING MATHEMATICAL SKILLS AND SCIENTIFIC THINKING AMONG STUDENTS WITH LEARNING DISABILITIES IN OMAN

**Abstract:** The current research is designed to investigate the impact of a BBL theory training program on developing mathematical skills and scientific thinking of mathematic disabled students. The proposed training program works as an independent variable comprising (22) training sessions. The methodology of the proposed program is based on integration between (Caine and Cain's) principles of BBL and (Karen D. Olsen, Susas Kovalik's) principles of BCL. The dependent variables were mathematical and scientific thinking skills. The validity and reliability of both independent and dependent variables were checked and confirmed by a pilot study, the study sample was divided into two groups; a control group of 36 participants; (16 males, 20 females), and an experimental of 35 participants; (16 males, 19 females) both with an average age (13 years). The research design used quasi-experimental design. Results showed the effectiveness of the training program employed.

**Keywords:** Brain-based learning theory, mathematical skills, scientific thinking, mathematic disabled students.

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## INTRODUCTION

Sciences of psychology, education and neuroscience have existed separately for a long time. This was obvious in Psychologists' interest in human functions and mental abilities such as learning, memorizing and thinking. Neurological and brain scientists were interested in the evolution of the brain work and its mechanism through special models. On the other hand, educators made sure to develop educational models based on psychological theories and their surrounding circumstances prevailing in each stage; hence several behavioral models which focused on teaching thinking have appeared. The most distinguishing models are: teaching thinking models, developing intelligence models and information processing models.

Learning is the natural function of the brain. The brain is instinctively provided with a range of dormant abilities such as the ability to self-correction, learning through experience by analyzing external data and the ability to create, innovate and explore patterns (Caine & Caine, 1994: 169).

The issue of brain functions and learning has been given attention of Cognitive Psychology researchers as it is correlated to the changes of age. Educational psychologist assured that the best method in enhancing students' learning process is addressing individual differences in cognitive functions with focusing on mental styles (Rothers, 1989: 413).

BBL theory,according to Jensen (2000: 45), has a number of characteristics, including:

A- It is a way of thinking about learning and working.
B- It is an understanding of the learning process, relying on the structure and function of the brain.
C- It is not an approach nor a prescription to be followed, but it encourages taking into consideration what is known about the nature of the brain in decision-making process.
D- It is an attitude of multi-systems derived from a number of systems such as: chemistry, neuroscience, psychology, and genetic engineering, and biology.
E- It is a system in itself, not an inadvance prepared design nor religious teachings.

BBL theory is a matter of learning with an activity and conciousness. In this theory, learning process takes place, if the brain is not prevented from the completion of its natural processes (Funhouse, 2001, 17).
This theory has drawn a natural, stimulating, supporting and positive method to increase the ability of learning/teaching process and this dimension depends on the learning methods that suit the structure of brain functions (Politano & Paquin, 2000, 5). This theory ensures integration between brain functions and emotions, a full stimulating environment, creating meaning and ensuring absence of threat. This theory neglects memorizing to learning for meaning, assures contextualization, learners' participation in decision making, taking responsibility, optimizing cooperative learning and applying knowledge (Duman, 2007, 35) Caine & Caine (2002) stated that the BBL theory has twelve principles that have been modified and developed several times to match continuous and modern brain research. The following are some of these principles:
A-All forms of learning use the inner body physiology.
B-The brain/ mind is sociable.
C-Searching for the context or meaning is an innate and instinctive.
D-Searching in context occurs through patterning.
E-Emotions and excitements are decisive for patterning.
D-Brain/mind works partially and holistically in concurrence.
E-Learning includes both centered and peripheral attention.

The current study uses some of the brain-based learning strategies in designing the brain-based learning theory study program. There are a number of research works that use the theory of BBL( e.g. Akyurekand Afacan 2013; Barbara 2002; Duman, 2010; Kiedinger, 2011; Seyihoglu and Kaptan 2012).

Geary (2004) found out that brain injury was the main cause of dyscalculia. In general, dyscalculia is an umbrella term used for various difficulties in learning mathematics, such as developmental dyscalculia, mathematical difficulty, learning numerical concepts difficulty, and learning numbers concept difficulty.

Scientific thinking skills such as: observation, classification, measurement, conclusion, forecasting, judging, induction, inference, data interpretation, variables control, etc. The application of these skills is one of the fundamental objectives of scientific education. When these skills are acquired by students, they help them to cope with renewable life problems. It should be noted that the advanced industrial countries' consideration of this goal in their educational programs has been a critical factor that helped them to achieve scientific and technological advancement. Oleimat, Khawaldeh and Qadri (2008), argued that scientific thinking has many features including:

1- Organized process, which goes through specific steps beginning with the purposeful note of a phenomenon, and ending with an explanation in the form of hypotheses validated by experiment.
2- Having a purposeful process with a specific and clear goal.
3- Avoiding occurring in isolation from human being , rather, it is a product of mental activity.

## STATEMENT OF THE PROBLEM

What is the effectiveness of a training program based on BBL theory in the development of mathematical skills and scientific thinking of mathematic disabled students?.

## PURPOSE OF THE STUDY

The aim was to examine the effect of a BBL on mathematical skills and scientific thinking of grade 10 Omani students. To further understand this process, teachers can apply this research findings to create a safe, stress-free classroom atmosphere that engages students' minds, improving their mathematical skills, and that, in turn, should help to ameliorate their scientific thinking.

## HYPOTHESES OF THE STUDY

The following hypotheses were to be verified :
1- There are statistically significant differences in pre- post-test scores mean of the experimental group on a specially designed mathematical skills test.
2- There are statistically significant differences in pre- post-test scores mean of the experimental group on a specially designed scientific thinking test.
3 – There are statistically significant differences in post-test scores mean between control and experimental groups on a specially designed mathematical skills test.
4- There are statistically significant differences in post-test scores mean between control and experimental groups on a specially designed scientific thinking test.

## METHODOLOGY

## RESEARCH METHOD

Quasi-experimental research method was employed.

Participants: A sample of 71 students in grade 7 of basic education in the Sultanate of Oman with LD was invited to participate in the study. Those who demonstrated low achievement scores on reading comprehension test (standardized test Mourad, 2015) (i.e., at least 1.5 [SD] below their same age people( APA, 2013,P.70 ; Mourad, 2018, P.109), though their normal levels of intellectual functioning( Mourad, 2012; Mourad & Amaal, 2013; Hesham& Rasha, 2014 ),the absence of any neurological or motor disorders(Al Said, 2014; Mohammed, 2014, Omema, 2015) were included. The sample was randomly divided into two groups; experimental (n= 36 boys only) and control (n= 35 boys only). The two groups were matched on age, IQ, achievement, mathematical Skills, and scientific thinking.

Table 1. pretest mean scores, standard deviations, T- value, and significance level for experimental and control groups on age (by month), IQ, achievement, Mathematical Skills, and Scientific thinking.

| Variable | Group | N | M | SD | T | Sig. |
|---|---|---|---|---|---|---|
| Age | Experimental | 35 | 148.57 | 2.84 | 0.472 | 0.547 |
| | Control | 36 | 148.31 | 2.91 | | |
| IQ | Experimental | 35 | 108.18 | 6.13 | 0.796 | 0.383 |
| | Control | 36 | 108.59 | 6.53 | | |
| Achievement | Experimental | 35 | 41.13 | 1.87 | 0.613 | 0.393 |
| | Control | 36 | 41.39 | 1.57 | | |
| Mathematical | Experimental | 35 | 91.32 | 3.17 | 0.823 | 0.315 |
| Skills | Control | 36 | 91.66 | 3.21 | | |
| Scientific | Experimental | 35 | 25.25 | 2.29 | 0.351 | 0.651 |
| thinking | Control | 36 | 25.39 | 2.61 | | |

DATA COLLECTION TOOLS

*Raven matrices scale (Raven., Styles and Raven, 1998).*

*An academic achievement test*: The end-of-year examination results of the participants in standardized and marked Math test by the teachers, and provided the summative evaluation scores for the analysis. Hence, scores in the Math test served as measures of students' achievement.

*Mathematical Skills Scale*: (Ersoy and Baser, 2013). It is a 5 Likert type scale that has four factors [higher order thinking tendency (6), reasoning (4), mathematical thinking ability (8) and problem solving (7)] and 25 items. Cronbach Alpha Coefficient was found to be.78.

*Scientific thinking scale*: Through informed researchers on a number of literature and scientific studies and tests of scientific thinking in this area, so the researchers preparing a test of scientific thinking knowledge of students' abilities and mental scientific potential. Then re-test in accordance with the following steps:

a. Identifying scientific thinking skills: After consulting specialists in the field, it has been agreed to determine (7) skills of scientific thinking, namely: (a sense of the problem, identifying the problem, the imposition of hypotheses, choice of hypotheses, conclusion, and the application).

B. Preparing paragraphs for the test: According to the literature and previous studies as Alabeygi (2005), Shayal Al alam (2009) and Alhaimed (2011), paragraphs were prepared, which, caught up with the students' characteristics of this school stage has become a test in its final form consisting (6) questions for the job.

Test Authenticity: the researchers relied on the virtual and logical honesty to extract test the authenticity and knowledge of its suitability to measure developed for him.

C. Arbitrators in the field of educational and psychological sciences and methods of teaching Mathematic and supervisor specialists for physics curriculum and teachers numbered (16) professors specializing. Researchers made proportion (80%) to be an accepted paragraph for the test. final test consisting of (38) questions and four alternatives.

D. Application of the exploratory test: The researchers applied the test on an exploratory sample of community group, (58) students in order to calculate the discriminatory paragraphs force, and the right time to answer.

RESULTS

*Question 1*: Are there any statistically significant differences in pre- post-test scores mean of the experimental group on a specially designed mathematical skills test? To answer this question, T test was used.

Table 2. Paired t-tests of difference between pre and post application for exp. group in mathematical skills.

| Test | | | | |
|---|---|---|---|---|
| | Post | pre | T | Sig. |
| Mathematical skills | 106.51 | 91.32 | 7.59** | 0 .000 |

Note: **P <0.01

For mathematical skills, regarding table 2, the result shows that there is a statistically mean difference for achievement (t=7.59, p < 0.01).

Question 2: Are there any statistically significant differences in pre- post-test scores mean of the experimental group on a specially designed scientific thinking test? To answer this question T-test was used.

Table 3. Paired t-tests of difference between pre and post application for experimental group in scientific thinking

| Test | | | | |
|---|---|---|---|---|
| | Post | pre | T | Sig. |
| Scientific thinking | 30.19 | 25.57 | 5.86** | 0 .000 |

Note: **P <0.01

For scientific thinking, regarding table 3, the result shows that there is a statistically mean difference for total score (t=5.86).

Question 3: Are there any statistically significant differences in post-test scores mean between control and experimental groups on a specially designed mathematical skills test? To answer this question, T test was used s.

Table 4. Independent samples t-test for the performance of both groups on the mathematical skills.

| Test | | | | |
|---|---|---|---|---|
| | Experimental | Control | T | Sig. |
| Mathematical skills | 106.51 | 92.53 | 6.21* | 0 .01 |

Note: **P <0.01

For Mathematical skills, regarding table 4, the result shows that there is a statistically mean difference for Academic achievement (t=6.21, p < 0.01).

Question 4: Are there any statistically significant differences in post-test scores mean between control and experimental groups on scientific thinking test? To answer this question T-test was used.

Table 5. Independent samples t-test for the performance of both groups in the scientific thinking

| Test | | | | |
|---|---|---|---|---|
| | Experimental | Control | T | Sig. |
| Scientific thinking | 30.19 | 26.01 | 26.01 | 0 .01 |

Note: **P <0.01

For scientific thinking, regarding table 5, the result shows that there is a statistically mean difference for total score (t=5.16).

## CONCLUSIONS AND DISCUSSION

There is a statistically significant difference between the mean scores of the experimental

group on the pre and post administration of the Mathematical skills test in favor of the post administration, this indicated the equality of the suggested program. There is a statistically significant difference between the mean scores of the experimental group on the pre and post administration of the scientific thinking in favor of the post administration, this indicated the equal effect of the suggested program. There is a statistically significant difference(0.01) between the mean scores of the experimental group and that of the control group of Mathematical skills test in favor of the exprerimental group. There is a statistically significant difference(0.01) between the mean scores of the experimental group and that of the control group of scientific thinking in favor of the exprerimental group. The value of Eta-Squar ( $.\eta^2$) which is (.115) indicates that the program has a high effect on developing achievement, it also indicates that the program clarifies the diversity between the students'scores in the experimental group when they were compared with those of the control one. Eta-Squar ( $.\eta^2$) indicated that the mean score of the expermental group occurs in (78) for the control group and this indicates that the mean score of the experimental group is higher than (78) of that of the control group scores or it indicates that the mean score of the expperimental group incudes 78% of the control group scores. The value of Eta-Squar ( $.\eta^2$) which is (.239), indicates that the program has a great effect on developing the scientific thinking of the experimental group in the post test . It also indicates that the program clarifies (24.1%) of the diversity in the students'scores in the scientific thinking in the post test when they are compared with the same group scores in the pre application of the test and it is a good quantity of diversity of the program and this indicates the effectiveness of the program.

In previous research, Lewis (2014) stated that students with MLD have a different way of scientific thinking. She thought that students with MLD did not mean to have a lack of mathematical skills, but there are different ways of thinking in mathematical skills. In our finding, it can be concluded that students have different ways of thinking in understanding the operation of Mathematical skills addition. In the addition operation, students understand the common denominator approach differently, students add, not multiply the numerator by the same number with the denominator. In multiplication operations, students only perform multiplication operations on the numerator; they do not multiply the denominator.

Another finding from Lewis (2016a) concluded that adolescent students with MLD are experiencing scientific thinking, especially in scientific thinking comparison subjects, either fractional comparisons with the same denominator or in scientific thinking involving a half scientific thinking. She suggested researching with younger MLD students as the subjects. Although this study involved younger students with MLD, a similar result was found: students with MLD have difficulties in resolving the problem of scientific thinking comparisons.

Furthermore, Lewis (2016b) explained that the partitioning activity was probably the root of understanding the quantity of Mathematical skills in regular students. Students with MLD may not follow this pattern of development. In our finding, Indonesia's national curriculum teaches mathematical skills with partitioning activities, which are beneficial for regular students, but not necessarily helpful to students with MLD; this can happen because MLD students do not follow a developmental pattern like their regular peers.

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