THE EFFECT OF APPLYING MEMORY PROGRAM ON STUDENTS WITH MATHEMATICS LEARNING DISABILITY

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Abstract

Mathematics learning disabilities were discussed as a disorder in the third edition of Diagnostics and Statistical Manual of Mental Disorders in 1980. The disorder is defined as disability in doing calculus skills regarding the child's IQ and expected educational level. In general classification, the disorder is one of the four prevalent ones. On the other hand, mathematics learning disability is a term for a wide range of enduring disabilities in the field of mathematics. researchers consider the problem in counting numbers, comparing quantities, distinguishing numbers and working memory to be among the valid indices of early diagnosis of mathematics learning disability in children.This research was conducted to study the effect of active memory training on improvement of math educational performance in students with arithmetic learning difficulty. The third grade schoolboys with mathematics learning disability studying in Rasht participated in this research between 2010 and 2011. Multi-stage cluster random sampling was applied to select the participants. Then, two classrooms were randomly chosen among boy primary schools of each area.Fifteen training sessions were designed and held within three months according to

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DehneducFindings:ational program. The data from research was analyzed by covariance analysis method. . Results of covariance analysis showed that taking the pretest scores as covariant variable, active memory training interventions were effective in improvement of math educational performance of students with arithmetic learning difficulty.Conclusion:Studies indicated that this memory could be increased through training. The active memory-associated brain activity could increase after training it. Interventions for memory based on teaching strategies were related to this memory. In this research, much care was exercised so that these children have no problem in the above-mentioned processes. This issue was not considered in most of the research carried out on the memory of children with learning difficulties.

Key words: *Mathematics Learning Disability, Applying Memory, Working memory*

Introduction

Mathematics learning problems appear at primary school period and continue till secondary school and high school. Beside being considered as disabilities at school, they also remain in adulthood and routine life. Mathematics learning disabilities were discussed as a disorder in the third edition of Diagnostics and Statistical Manual of Mental Disorders in 1980. The disorder is defined as disability in doing calculus skills regarding the child's IQ and expected educational level. In general classification, the disorder is one of the four prevalent ones. On the other hand, mathematics learning disability is a term for a wide range of enduring disabilities in the field of mathematics [Dowker،2005]. Concerning mathematics learning, Gersten, Jordon, and Flojo note that children's problem in learning math begins during the years before primary school [Gersten،2005]. These researchers consider the problem in counting numbers, comparing quantities, distinguishing numbers and working memory to be among the valid indices of early diagnosis of mathematics learning disability in children. Fuchs and Fuchs [Fuchs

, Fuchs 2005،] estimated the epidemics of mathematics learning disability at primary school between %5 and %8 and Ramezani [Ramezani،2001] as %5. Mazzocco and Hanich [-Mazzocco،2010] have regarded three types of mathematics learning disabilities including disability in semantic memory, procedural memory, and visuo-spatial memory. The first type refers to the problem with recovering basic math realities from semantic memory. Geary [Geary،2004] has demonstrated that this group of children has difficulty in decoding information from long term memory and probably has reading disability as well as low math performance.

The second type of disability is related to processing rate and calculation mistakes in doing math assignments. This group of children has problem with working memory and as a result use non-developed strategies such as counting by fingers in math calculations. The third type is visuo-spatial processing disability manifested by math errors. In his study on hundreds of children with mathematics learning disability, Geary [- Geary،2006] has provided sound evidences that these children have weaknesses regarding visuo-spatial processing, motor-mental organization, visuo-perceptual organization, and concept building. In recent years, the potential neuro-psychological factors are studied with respect to the neuro-psychological qualities of children with mathematics learning disabilities. Many researches have shown that the main neuro-psychological quality students with mathematics learning disability includes problems with learning and remembering mathematics concepts, difficulty with calculation, non-developed strategies for problem solving, memory problems, visuo-spatial processing insufficiencies, deficiency in executive functions, attention and working memory [Geary2004، Geary،.2006 Jordan,Glutting.Raminen .، 2010Bley2001. Kroesbergen،,Vanluit، Mass2004 .Semrud،2005]. In several studies, it is demonstrated that students with mathematics learning disability have significantly lower performance regarding the functions of working memory, names memory, faces memory, visuo-spatial working memory, and long term memory compared to ordinary students [- Korkman،, Pesonen،1994. Korkman،Hakkinen-Rihu،2010.Farahani،2007. Swanson, Jerman،2006. – Rousselle، Noel،2007]. Working memory is defined as a cognitive system responsible for temporary storing and processing information [- Holmes. Gathercole Dunning،2009.]. In fact, this is a comprehensive system integrating performances and long term and short term memory sub-systems [Dehn،2008]. There are varieties of working memory: 1) verbal working memory, 2) visuo-spatial working memory, and 3) executive working memory [Dehn،2008].

Working memory is the foundation of thinking and mathematics and reading learning in children [Dehn،2008]. Mabbott and Bisanz proved that students with mathematics learning disability have significantly lower performance regarding calculation skills, working memory and perceptual knowledge compared to ordinary students.In a study, Wilson and Swanson [Mabbott.Bisanz،2008] showed that – aside from age – mathematics learning disability accompanies the weak functions of working memory in visuo-spatial and verbal areas. SwastonoSachse Lee [.Korkman،Hakkinen-Rihu،2010] found out that children with mathematics learning disability act weakly in working memory, response inhibition, and organizing compared

to control group. Yet, training the memory can reduce such children's problems [Dehn،2008]. For instance, Hutton and Towse [Hutton.Towse،2001] realized that there is significant relationship between the span of numbers and performance in mathematics tests. Results of the study by Isfahanian et al [Esfahaniyan.Vafayi.Ashayeri ،1999] also indicated the significant relationship between working memory and mathematics achievements in children and the anticipatory role of the memory in different math skills was emphasized based on Iranian schools' curriculum. The interventions of working memory are based on strategies related to the memory. A number of studies confirm that working memory capacity can be improved using training [Dehn،2008]. Olesen et al discovered that brain activity which is related to working memory enhances after training and working on this memory [Olesen.Westerberg.Klingberg،2004]. In a study on children with mathematics learning disability, the children performed better with their working memory and had fewer problems with mathematics after the end of instructional and follow-up courses [Holmes.GathercoleDunning،2009].Mirmahdi et al [Mabbott.Bisanz،2008] examined the effect of training executive functions including working memory in children with mathematics and reading learning disabilities. Results showed that the children's math and reading performances improved after the end of instructional and follow-up courses. Abedi et al [-Abedi.Atashpour.Khoddami،2011] also studied the effect of teaching executive functions including working memory on mathematics learning disability. Based on the results of the above studies, the main objective of the present research was to examine the efficacy of training working memory on the improvement of educational performance in children with mathematics learning disability. On the other hand, the major issue of this study is whether training working memory affects the improvement of the educational performance in children with mathematics learning disability?

Materials and Method

Research design: Research design was of pre-test-post-test types with control group. Independent variable was training working memory and dependent variable was the math educational performance of children with mathematics learning disability.

Participants

The third grade schoolboys with mathematics learning disability studying in Rasht participated in this research between 2010 and 2011. Multi-stage clusterrandom sampling was applied to select the participants. Accordingly, ten primary schools were randomly chosen among the education areas of Rasht (the city includes five education areas). Then, two classrooms were randomly chosen among boy primary schools of each area. The third grade teachers were asked to introduce students with mathematics learning disability by screening method and based on the checklist signs of the fourth edition of Diagnostics and Statistical Manual of Mental Disorders Revised. Then, 59 students were introduced by the teachers on whom a diagnostic test failure accounts and math educational performance test in third grade were administered to diagnose mathematics learning disability. As a result, 51 students had mathematics learning disability among whom 30 students were randomly placed in groups of 15 (a test group with mean age=9.4 years and a control group with mean age=9.3 years). And, independent variable (training working memory) was executed on the test group. Criteria for entering the study included being a third grade schoolboy with an average or higher IQ, intact sight and hearing, mathematics learning disability in a diagnostic test failure accounts and math educational performance test in third grade, without any other disorders. Exit criteria also included IQ below average (≤85), problem with sight and hearing, having other disorders. Based on the results, mean test group was enhanced after interventions.

Instrument

1- Wechsler Intelligence Scale for Children – Fourth Edition (WISC – IV): This is the revised form of Wechsler Intelligence Scale for Children – Third Edition (1991) developed in 2003 by Wechsler for children between 6 and 16 years old. This fourth edition provides a measurement of general IQ and four main scores including verbal comprehension, perceptual reasoning, working memory and processing rate. This test is adapted and normalized on a sample of Iranian children by Abedi [30]. The reliability of sub-tests was reported from 0.65 to 0.95 in test-retests and coefficients were from 0.71 to 0.86 in split-half method. Wechsler Intelligence Scale for Children – Fourth Edition (WISC – IV) was used for measuring IQ and working memory in two groups.

2- Diagnostic test failure accounts: This test is developed by Farahani [Farahani،2007] for diagnosing students with mathematics learning disability in the first to fifth grades of primary school in Isfahan. The diagnostic test failure account in third grade was

administered in this study to determine the students with math learning disability. The test consisted of seven sub-scales including account test, geometry, addition and subtraction, multiplying and dividing, fraction and decimal, measurement and problem solving. Test correlation was calculated using Iran-Keymath mathematics test and Wesch-R intelligence scale. The correlation of the sub-tests and total scoreof this test were from 0.87 to 0.89 using Iran-Keymath and the correlation was 0.79 using account test and Wesch-R intelligence scale**.** To determine the reliability of the test, three methods (Chronbach alpha, split-half, and fixed test-retest) were applied, and results were respectively gained: from 0.74 to 0.92 and totally 0.93, from 0.71 to 0.91 and totally 0.89, and from 0.82 to 0.92 and totally 0.92 [Farahani،2007].

3- Math educational performance in the third grade: This test is developed for measuring math educational performance by the instructional department of the third grade of primary school. Its content validity was revised and confirmed by Delphi method and its reliability coefficient was gained using test-retest and Cronbach's alpha respectively as 0.89 and 0.82. An integration of the two was the measure of diagnosis in this study.

Research Process:

upon administration of dyscalculia diagnostic test, third grade math educational performance, and Wechsler intelligence scale for children version 4, and also obtaining the consent of students and their parents to participate in research, 30 children were selected and put into two groups of 15 students (15 as experimental group and 15 as control group). Fifteen training sessions were designed and held within three months according to Dehn educational program [Dehn،2008]. Each training session lasted one hour, and was held three sessions a week. The experimental group took 4 months to receive the training. Two master's of children psychology with special needs were consulted to teach the children. They were fully trained and coordinated in several sessions. In the end of each training session, the parents too were given homework to do some of the exercises. Training was also administered in 3-member groups in Bamdad Elementary School (the students' training place). The data from research was analyzed by covariance analysis method.

Findings:

In order to analyze data, mean and standard deviation were used. To determine efficacy of active memory teaching, covariance analysis test of data normalcy and consistency of test groups' variances were used. Results of table 3 concerning mean and standard deviation of experimental and control groups in the pretest and posttest of educational function and results of table 4 show that taking into account the pretest scores as covariant variable, active memory training intervention led to a significant difference between theexperimental and control groups ($p<0.001$) and the influence was 0.89. This means that 89% of posttest variance (math educational performance) was related to active memory training intervention. Statistical power is 100. Therefore, memory training intervention is effective in controleducational performance. The results of Kolmogrov-Smearnov, Shapiro-Wilk, and Lovintests indicated that the condition of normalcy, consistency, and variances isestablished. The results of Lovin test indicated that the variance of scores was equal in two groups ($F=1.85$&$p>0.05$).

Table 1) pre-test - post-test control group

Group	RandomSelectionTests	Pretest	The independent variable	Posttest	Psychological intervention
The experimental group	R	T_1	X	T_2	Working Memory
Control	R	T_1	-	T_2	Control Group

Table2) Results ofKolmogorov-Smirnov-Wilkienormal distribution oftestscoresforacademic performance

Kolmogorov-Asmyrtf				Shapiro Wilkie		
Groups	Statistics	Degrees of freedom	Significance level	Statistics	Degrees of freedom	Significance level
The experimental group	0/18	15	0/20	**0/88**	**15**	**0/24**
ControlGroup	0/21	15	0/23	**0/78**	**15**	**0/17**

Table 3), the mean and standard deviation between experimental and control groups in third grade math achievement test prep

Type oftest	trials		Controlled	
	Mean	SD	Mean	SD
Pre-test scores	10/20	3076	10/80	2064
Posttestscores	14/80	2/64	11/01	2/85

Table4) summarizes theresults of theANCOVAtest fordifferences betweencontrol and experimental groupsinthird grademathematicsachievement

	Square	Degrees of freedom	Mean square	f	Significance level	Etasquared	puissance
Pretest	8/18	1	8/18	6/87	0/008	0/25	0/79
Group	154/55	1	154/55	129/87	0/001	0/89	100
Error	32/21	27	1/19	-	-	-	-

Discussion

This research was conducted to study the effect of active memory training on improvement of math educational performance in students with arithmetic learning difficulty. Results of covariance analysis showed that taking the pretest scores as covariant variable, active memory training interventions were effective in improvement of math educational performance of students with arithmetic learning difficulty. The results of this research conform to those of previous works [Dehn‹2008,Holmes. Gathercole.Dunning‹2009,Olesen.Westerberg.Klingberg‹‹2004Mabbott.Bisanz.Computational 2008‹Bisanz.Computational2008‹,Abedi‹2011].The findings of various research showed that children with arithmetic learning difficulty have a weak performance in active memory [Korkman‹, Pesonen‹1994. Korkman‹Hakkinen-Rihu‹2010.Farahani‹2007. Swanson,

Jerman‹2006.Rousselle‹ Noel‹2007]. Studies indicated that this memory could be increased through training. The active memory-associated brain activity could increase after training it. Interventions for memory based on teaching strategies were related to this memory [Olesen.Westerberg. Klingberg‹2004]. In their research works, Svanson and Sachzli [Swanson.Sachse Lee‹2001] pointed out to the significant role of arithmetic functions. According to these results the mean score of test group increased after intervention.

They referred to active memory as improving mathematics in children with arithmetic learning difficulty. They found that training this memory could reduce the children's difficulty. Abedi et al. [Abedi‹2011] studied teaching executive functions such as active memory in arithmetic learning difficulty. The findings of their research proved that children would improve their arithmetic function upon completion of training. According to the results of this research and other studies referred to above it could be concluded that active memory training could reduce the problems in children with arithmetic learning difficulty. To explain other findings of research it could be stated that to dominate over arithmetic works, children should achieve mastery over a set of skills. These skills were neuropsychological aspects such as active memory and attention.

These skills could be acquired through experience, training, and learning. Most children performed the skills automatically but children with arithmetic learning difficulty faced problems learning these skills and hence should be trained. To elaborate more, it could be stated that as children with arithmetic learning difficulty had problem with active memory, teaching this memory and its components could strengthen the memory. In other words, children were trained proportionate to the components of active memory such as verbal, visual, spatial using forms, words, and numbers. This would activate that part of brain associated with active memory. These trainings boosted verbal, visual-spatial active memory and hence leading to improvement of arithmetic function in the student. Strengthening active memory as a neuropsychological prerequisite could improve arithmetic function of students with learning difficulty. As mentioned before, there was a scarcity of research work on arithmetic difficulty with reading and writing as concerns active memory. Yet, various studies proved that active memory and its various types such as verbal and executive memory were involved in arithmetic learning. Based on this research, neuropsychological variables were regarded as the minimum predictors of arithmetic progress. When neuropsychological assessment was added to IQ scores, a proper prediction of arithmetic progress of students would be presented. Identification of the problems of students

with arithmetic learning difficulties in neuropsychological aspects such as active memory could help the educational authorities understand the problems or design and prepare educational programs. Regarding the influence of teaching active memory in improving the arithmetic performance in students with arithmetic learning difficulty, it could be concluded that focusing on teaching active memory as a fundamental math learning skill could be an effective approach to cure arithmetic learning difficulties. A limitation of this research was that the arithmetic problem of students with arithmetic learning difficulty could be associated with deficiency in other neuropsychological aspects such as attention, visual-spatial processing, or other components of executive function (exclusive of active memory). In these children, memory problems could be a secondary issue. In this research, much care was exercised so that these children have no problem in the above-mentioned processes. This issue was not considered in most of the research carried out on the memory of children with learning difficulties.

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