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Original Research

Effectiveness of an educational neuroscience-based curriculum to improve academic achievement of elementary students with mathematics learning disabilities

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Abstract

Background: The present study evaluated the effectiveness of a curriculum based on educational neuroscience on improving academic achievement in elementary students with mathematical learning disorder in Shiraz.

Methods: This is a quasi-experimental research which was done on students with math learning disabilities from grades two to six in Shiraz District 2 and 4. 47 students fulfill the inclusion criteria, due to the exclusion criteria 31 students enrolled in the study. They are randomly assigned to experimental and control groups. All of them completed the pre and post-test training in the control group was based on the traditional teaching style and the curriculum patterns that were implemented. The training in the experimental group was based on educational neuroscience curriculum model. Differences are considered statistically significant at $P \leq 0.05$ and 95% confidence interval of the difference is considered.

Results: The results showed that the mean of the control and experimental groups in numerical understanding variable was respectively: 28.60 and 36.87, in numerical production variable was: 15.13 and 20.06, in numerical calculation variable was: 8.80 and 13.62. The level of significance in the group in all three variables of numerical understanding, numerical production and numerical calculation was 0.001, which means that the experimental group performed better in the post-test than the control group.

Conclusion: Educational neuroscience interventions such as the underlying math learning skills can be an effective approach in the treatment of math learning disabilities, the use of this curriculum has also directly improved attention structures and indirectly improved learning disabilities.

Introduction

Learning disabilities are among the most important causes of poor academic performance, and a primary reason many students have difficulty learning content each year. Such students usually have medium to high intelligence but perform poorly in almost identical educational conditions compared with other students. Despite having moderate to high intelligence, being in an appropriate educational setting, lacking significant biological impairments and acute social and psychological problems, they are not able to learn subjects in specific areas (reading, writing, calculating).[1]

In a recent study by Ismail et al, the overall prevalence of learning disorders among first to sixth grade students was 16.5%, and writing, reading, and mathematics learning disorders were reported to be 12.5%, 11.2%, and 10.5%, respectively.[2]

The most important features of children with mathematical learning disorders are difficulties in learning and remembering mathematical concepts. Accompanying important characteristics are difficulty in computing, insufficient problem solving strategies, excessive time spent finding solutions, and high error rates in performing mathematical calculations.[3] Various studies have identified several elements of children's characteristics, family aspects, and social environment as major contributing factors in the formation of childhood disorders and their lack of academic achievement.[1-5]

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Recent advances in brain science and research have led to a wave of new insights into neural mechanisms underlying learning, memory, growth, thinking, excitement, and motivation, and have led many researchers to use neuroscience findings to improve thinking and educational policies. Hall believes that neuroscience and education cannot be directly linked, but "cognitive neuroscience" can link neuroscience and psychology, and the result can be applied to education.

Neuroscience research helps educators learn about brain mechanisms that may discern similarities and differences among students, and can provide ways to diagnose learning problems earlier.[6] In addition, some students need different types of support because their behavior and learning functioning can be based on different neurobiological reasons. Understanding these differences helps teachers become more aware of students who exhibit such behaviors and more willing and able to help them.[7]

Brewer and Hall insist on the impossibility of a direct link between neuroscience and education, but many others, such as Byrnes and Fox,[8] Blakemore and Frith,[9] Fischer et al,[10] and Gardner[11] support the establishment of a direct link between neuroscience and education while recognizing the significance of cognitive psychology as an important foundation. They claim that each of the mediating domains introduced by Brewer and Hall can have important educational implications. They also maintain that now is the time to study the implicit and explicit educational implications of neuroscience research and employ these findings in conjunction with other principles of education to improve educational theory and practice.

Thus, the prevailing view is that neuroscience has the potential to be a valuable source of information for educational thinking and practice. In addition, some survey studies in recent years have shown agreement between educators and neuroscientists on the need for a link between neuroscience and education.[12,13] Neuroscience and education can work together and interact directly as educators obtain information from neuroscience studies about how the brain learns optimally (as a learning organ). This interaction can also take place indirectly, as neuroscience alters the knowledge of the psychological foundations of behavior and mind, and these psychological findings can influence educational thought and policy.[14,15] This relationship between neuroscience and education has led to the emergence of a nascent discipline of educational neuroscience.

Educational neuroscience, along with studies of the mind, brain, and education, is part of a broader interdisciplinary field, learning science, which seeks to link knowledge about the brain and mind with knowledge about curriculum and pedagogy. This interdisciplinary area is composed of findings from neuroscience, cognitive sciences, psychology, and educational sciences, whose main mission is to create a solid scientific foundation for the study of learning and education.

Many teachers, policymakers, and scholars believe that neuroscience provides us with information highly relevant to education, and therefore, as this amount of information increases, educational science is required to pay attention to it.[16]

The quantity of research done in educational neuroscience in classrooms reflects the fact that educational neuroscience has been effective in improving students' learning.[17-22]

Therefore, in accordance with the above mentioned points, as well as research showing poor academic performance among children with learning disabilities in mathematics, this study evaluates the effectiveness of using an educational neuroscience approach in supporting academic achievement of students with mathematics learning disabilities.

Materials and Methods

The research method is quasi-experimental, with a curriculum model based on educational neuroscience. This type of curriculum has elements such as purpose, content, teaching methods, etc., that are based on the opinions of experts in cognitive neuroscience and education, as well as on the findings of cognitive neuroscience. Table 1 outlines the steps of the research, information sources and the method of conducting the research in developing the intervention plan[23] (attached). This model is considered an independent variable, student academic achievement is a dependent variable, and intelligence quotient is a control variable.

The statistical population is comprised of 47 students with learning disabilities from second to sixth grade selected from Districts 2 and 4 in Shiraz, Iran, in the academic year of 2017-2018. The students were identified in educational centers according to expert evaluation of exceptional education psychologists as having a mathematics learning disability. All 47 students were eligible to participate in the study; a total of 31 participated and were randomly assigned to experimental (n=16) and control (n=15) groups. It should be noted that a sample size of 15, according to previous research[24-26] and using NCSS software, for each subgroup with a power=0.8 and an effect size=0.89. To increase the chance of homogeneity, individuals were randomly assigned to the control and experimental groups (Figure 1). Training in the control group was based on the traditional teaching style and curriculum ("School Syllabus" or SS). The experimental group used an educational neuroscience curriculum ("Cognitive Neuroscience Curriculum" or CNC).

The experimental design was administered to all second to sixth grade students for five months with eight sessions per month. The control group was also selected from Shiraz Districts 2 and 4 learning disorders centers. Table 2 summarizes each of the five-month intervention topics.

Table 1. Research stages and information resources in the intervention program

Research stages	Data sources	Methods	Duration (months)
Step 1: Design and identification of pattern elements	- Interviews with experts and specialists in educational sciences and cognitive neuroscience - Study of upstream documents and scientific and research resources at national and international level	- Grounded theory (contextual theory) - Analytical and inferential method	- 6 month - 4 month
Step 2: Validation of the extracted content related to the proposed model	Curriculum specialists and cognitive neuroscientists	CVR	1 month

Table 2. Summary of the content of the intervention program

The content of Each Session	Sessions' Goal
First Month: Attention Skill	The goals, exercises, and instructions in this section include: • Understanding the details of the relevant image. • Identifying similar shapes. • Reading the text and find the number of letter "M" in the text. • Playing with matchsticks, strengthening auditory memory and strengthen attention and concentration.
Second Month: Attention Skill	• Providing mindfulness and concentration exercises and finally providing math book exercises related to each student's grade level, such as detailing the pictures of the boos.
Third Month: Verbal Learning Skill	The goals, instructions, and exercises presented in this section include: • Providing the children with a series of words, shapes or numbers and words and shapes to see them first and on the following pages, he or she should find shapes or words; that is to say, which of the following they saw on the previous pages and checked, finding the meaning of the words or their synonyms as well as contrasting the words. • Sorting the jumbled words in each line and making sentences. • Writing words on the line or Say them out loud, line the word inconsistently in each row. • Finally provide math book exercises related to each student's grade level.
Forth Month: Working Memory Skill	The following goals, instructions, and exercises were also followed: • Showing the minor shapes drawn on separate cards two by two to the child, and then covering the cards and asking the child to enlarge and find them with the help of memory. Then draw two dimensional shapes and gradually increase the two shapes (3 to 4 to 5). • In the right column are words that the child should see carefully and point to them with his/her finger. Then the words are covered and the child has to complete the unfinished words using his/her memory. We ask the child to start with the first letters. • The student should answer the following questions. At the same time, we record the time spent on answering the questions. What did you eat this morning? Where did you go on holiday last week and what did you do? What was the name of the last program you watched on television? • Providing math book exercises related to each student's grade level, such as solving a Sudoku table.
Fifth Month: Spatial Thinking and Perception Skill	The goals, instructions, and exercises presented in this section include: • On the next page, look at the set of logos at the top and the segments of logos at the bottom and match them. • Showing the right shapes one by one for a few seconds to show the children the accurate shapes. We ask the students to look at them, and then cover the shape to keep the dots in place. • So the child must first read the words in the box at the top of the screen and write in the air with their index finger. The words are then hidden inside the box, and the child uses his/her memory to place the word correctly in place for the words which are to be spelled correctly. • Providing math book exercises related to each student's grade level.

Data collection tools

1. Wechsler Intelligence Scale for Children (WISC-IV): This scale was developed by Wechsler in 1949, revised in 2003. In the WISC-IV test, five types of intelligence are calculated: verbal comprehension, perceptual reasoning, working memory, processing speed, and total intelligence. The reliability coefficient of this scale varies from 0.77% to 0.87% in verbal tests and between 0.69% and 0.89% in practical tests. The reliability coefficient of the test at 23-day intervals for verbal and practical scales varies from 0.94% to 0.87%, respectively.[27] This test was used at pretest and as an inclusion measure: since IQ is a control variable in this study, people with IQ levels between 86 and110 were considered for intervention and people with IQ levels outside this range were excluded from the statistical population of the study.

2. Shalev's academic achievement & diagnostic test of calculation: This test was developed by Shalev, Manor, and Grass Tesor based on the numerical processing model of McCloskey, Karamaza, and Basil. It consists of three parts. The first part is numerical comprehension, with eight subtests for counting, comprehension, matching, reading numbers, writing numbers alphabetically, comparing numbers, using mathematical symbols, and sorting numbers. The second part covers numerical production and contains subtests for simple, single digit addition, subtraction, multiplication, and division. The third part covers numerical computation and contains subtests for multicomponent computation for addition, subtraction, multiplication and division. All subtests in each of the three

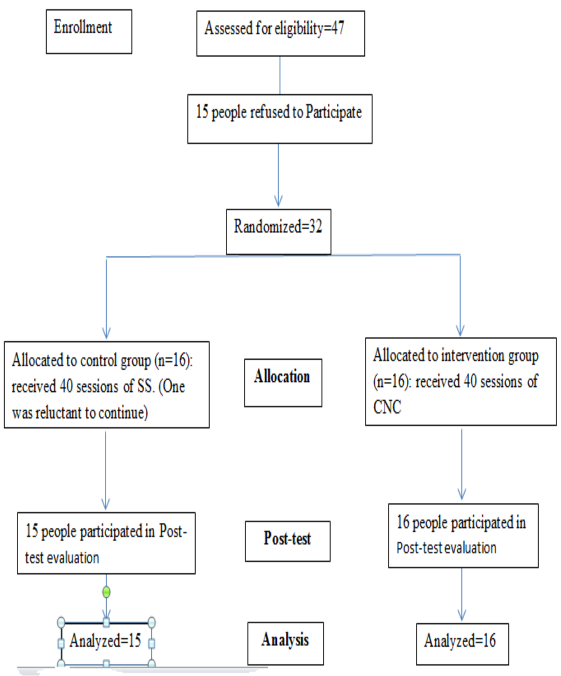

Figure 1: CONSORT flowchart of the study population. CNC; Cognitive-Neuroscience Curriculum. SS; School Syllabus.

sections contain five questions. Being a reference group test, the subtests have a total score of 100. The reliability of this test has been measured at 0.92 with a sample of 703 individuals.[28] In this study, the test was used to measure the academic achievement of students with mathematical learning disabilities at pre-test and post-test.

3. Iran Key-math Mathematics Test: Developed by Conley in 1988, the Key-math test is a reference criterion with rules for standard deviation. The test consists of three parts: concepts, operations, and applications. These sections are divided into thirteen subtests, where each section is divided into three or four domains. Its validity has been calculated using content validity, discriminant validity, and predictive validity and the concurrent validity is obtained to be between 0.55 and 0.67. Its reliability reported as Cronbach's alpha has been calculated to be between 0.80 and 0.84.[29] This test can be administered individually and after the student's scores in each of the subtests are calculated and their sum is obtained, based on the mean and standard deviation of the reference group that has already been standardized and is available for each grade, each student's standard score is reported as a Z-score. This test was used to match groups in terms of academic achievement at the pre-test.

Statistical analysis

Analysis of covariance (ANCOVA) was used to compare the effectiveness of intervention in the experimental group. All statistical analyses were performed using IBM SPSS Statistics version 21 (IBM SPSS Statistics, Armonk, NY, USA). Differences are considered statistically significant at $P \leq 0.05$.

Results

Sample group and demographic variables

In this study, participants with a mean age of 9.77±1.58 years were selected randomly from second to sixth grade. There was a significant difference in age between the two groups, given that the participants were randomly assigned to the control and experimental groups, and that the students were either born in the first or second half of each year, and thus inequality was observed in the age variable. Table 3 shows the frequencies of grade level and gender of participants of both groups; the groups did not differ significantly in terms of demographic variables, gender or educational grade (P=0.8 for grade level and P=0.2 for gender).

Pre-test

All participants were assigned to experimental or control groups after initial assessment with the specified tools. WISC-IV has four total scores: verbal comprehension, perceptual reasoning, working memory and processing speed. Table 4 shows these differences. According to the pre-test results, only the difference in perceptual reasoning

Table 3. Demographic Characteristics of the Study Groups

Characteristics	Experiment group		Control group		Chi-square	*P* value
	No.	%	No.	%		
Educational grade					1.36	0.85
Second	4	25	4	26.66		
Third	4	25	2	13.33		
Fourth	2	12.5	2	13.33		
Fifth	4	25	6	40		
Sixth	2	12.5	1	6.66		
Gender					1.51	0.28
Boy	10	62.5	12	80		
Girl	6	37.5	3	20		

Table 4. Comparison of the study groups at baseline intelligence subscales

Variable	Grouping	Mean ± SD	t	*P* value
Verbal understanding	Experiment	20.75±6.68	2.031	0.064
	Control	43.30±39.43		
Perceptual reasoning	Experiment	23±6.96	2.26	0.033*
	Control	28.46±4.99		
Active memory	Experiment	11.36±3.66	1.46	0.157
	Control	13.30±2.83		
Processing speed	Experiment	14.66±4.61	1.70	0.102
	Control	17.38±3.30		

*Significant at $P \leq 0.05$.

was significant (P = 0.03); there were no significant differences in the other subscales. The baseline for the section of the mathematical cognitive variable contains the scores from the Key Math and Shalev tests. The Key Math test has three scores: basic concepts, operations, and applications. Each of these three scores is compared in the experimental and control groups. The Shalev test has three scores: numerical comprehension, production, and calculation. Each of these three scores was compared between the two groups. According to the pre-test results, no significant differences were observed in the subscale test scores for either the Key Math or Shalev tests. In the baseline description section, mean differences between the experimental and control groups for all variables was assessed using independent t tests. Again, there were no significant differences between the groups in terms of basic concepts, operation applications, numerical calculation, numerical production, and numerical understanding variables. Both groups thus were comparable at baseline, and the pre-test scores did not differ significantly between groups.

Post-test

In this study, the Uni-Covariance method was used to answer the research question, and the results of the post-test, as the dependent variable, and the pre-test, as covariance, were entered into the model. Table 5 shows that the difference between the mean scores for the SS and CNC groups for academic achievement at the post-test for numerical understanding, production and calculation, respectively, were 463.395, 176.788 and 190.163. The value obtained from the test for the three variables expressed are equal to F = 13.25, F= 19.79 and F= 35.27 with a significance level of $P \leq 0.001$ for all three variables, which shows that this difference is significant compared to the pre-test control. Therefore, it can be concluded that the CNC intervention had a positive and significant effect on students' academic achievement.

Discussion

The purpose of this study was to investigate the effect of CNC model on improving the academic achievement of students with mathematical learning disabilities in Shiraz. The results indicate that the use of the CNC curriculum and its modern approach had a significant impact on improving students' learning.

The findings show that before the implementation of the CNC curriculum based on educational neuroscience strategies, the mean pre-test scores of students with mathematical learning disabilities in both the experimental and control groups were not significantly different. However, after exposure to the CNC model and comparing the two groups at post-test, significant differences were seen between the post-test scores of the two groups. The mean scores of the students in the experimental CNC group were significantly higher than those of the control group students. In other words, the results of the analysis of covariance suggested that the students who were trained using the Educational Neuroscience curriculum had significantly higher scores in the mathematics tests than the students who received the normal school education. Therefore, it can be inferred from the research findings that students' disabilities in learning mathematics require a comprehensive study of cognitive aspects and interventions based on research in this field. In terms of impact on academic achievement, the results of present study are in line with research findings that demonstrate the efficiency of brain-based curriculum models and educational neuroscience strategies.[18-22,30-33]

In educational neuroscience learning, the learning environment is designed in such a way that learner feels safe and at the same time experiences the challenge to enhance learning. Learning theory based on the findings of educational neuroscience has raised new issues in the field of education. Attention to the theoretical dimensions of this theory and its application in schools is of particular importance.

The findings of this study also highlight the effect of neuropsychological interventions on improving students' mathematics performance, since children's mathematical errors also follow different patterns according to neuropsychological differences in learning, including neurodiverse conditions.

In conclusion, this study finds that diverse activities improve students' performance; familiar and new aspects

Table 5. Uni-covariance results for shelve academic progress in pre and post-test parts

Variables Source		Type III Sum of Squares	Df	Mean Square	F	*P* value	Partial Eta Squared
Numerical understanding	Pre-test	0.170	1	0.170	0.005	0.945	0.000
	Post-test	463.395	1	463.395	13.251	0.000*	0.321
Numerical production	Pre-test	0.592	1	0.592	0.066	0.799	0.002
	Post-test	176.788	1	176.788	19.794	0.000*	0.414
Numerical calculation	Pre-test	17.204	1	17.204	3.191	0.085	0.102
	Post-test	190.163	1	190.163	35.274	0.000*	0.557

*Significant at $P \leq 0.05$.

of a subject can fulfill the need for search of meaning; and step-by-step instruction can be used as a tool for meaningful understanding of a complex idea, which improves students' unique performance in comprehension of the whole and the parts, increases self-confidence, and boosts students' willingness to engage with various mathematical problems.

Therefore, according to the above results, it is realized that educational neuroscience can have a positive effect on improving the academic performance of children, especially children with learning disabilities, by performing appropriate interventions geared towards neurodiverse learners.

In conclusion, despite having limitations such as the types of tools, ability to generalize the findings and sample selection, this study is indicated for further research with different types of learning disabilities according to gender, age and demographic characteristics. It is also recommended that principals and teachers design rich learning environments with educational games to improve and strengthen children's neural prerequisites for growth in such areas as executive functions, attention, visual-spatial processing, language, and memory.

Conclusion

Teachers' knowledge of brain functions and their proper use of brain-based learning principles in teaching as well as the application of challenging teaching methods in mathematics can contribute significantly to students' academic achievement in mathematics and a positive attitude. Learning is enhanced in an environment full of emotion controlling and information processing factors and leads to positive effects on students' academic achievement. Therefore, it is hoped that the findings of this study provide parents, educators, planners and education authorities with clearer perspectives to create a rich learning environment full of motivational factors.

Ethical approval

This study was approved by the Graduate Council of Tabriz University as project number 17/355.

Competing interests

There are no conflicts of interest.

Authors' Contributions

Acquisition of data, study concept and design: ZS. Analysis and interpretation of data: ZS and AM. Drafting of the manuscript: ZS. Critical revision of the manuscript for important intellectual content: EF, AM, YA. Statistical analysis: ZS and AM. Study supervision: EF, AM, Yousef Adib.

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References

1. Boustanzar R, Rezayi S. Developing intervention program focused and divided attention and investigating its effectiveness on working memory IQ in children with specific learning disorder. Journal of Learning Disabilities . 2017;7(1):136-142
2. Ismail R, Mohamed H, Soltan B. Prevalence of learning disabilities among a sample of primary school students. The Scientific Journal of Al-Azhar Medical Faculty, Girls. 2019;3(1):125-30. doi: 10.4103/sjamf.sjamf_65_18.
3. Sobhi D, Abolghasemi A, Dehghan H. Comparison of A, B, C and D brain quadrants dominance in normal students and students with learning disabilities. Journal of Learning Disabilities. 2014;3(4):59-79. [Persian].
4. Sharma N, Petchimuthu P, Gaur A, Kumar R. Prevalence of specific learning disability among schoolchildren between 8 and 12 years. Indian J Child Health. 2018;5(5):355-8. doi: 10.32677/ijch.2018.v05.i05.010.
5. Basim Ali CT, Fysal N, Akhila Thasneem A, Aswathy PS. Assessment of knowledge level on learning disability among primary school teachers. Int J Contemp Pediatrics. 2019;6(2):431-5. doi: 10.18203/2349-3291.ijcp20190545.
6. Alferink LA, Farmer-Dougan V. Brain-(not) based education: dangers of misunderstanding and misapplication of neuroscience research. Exceptionality. 2010;18(1):42-52. doi: 10.1080/09362830903462573.
7. Ferrari M. What can neuroscience bring to education? Educ Philos Theory. 2011;43(1):31-6. doi: 10.1111/j.1469-5812.2010.00704.x.
8. Byrnes JP, Fox NA. Minds, brains, and education: part II. Responding to the commentaries. Educ Psychol Rev. 1998;10(4):431-9.
9. Blakemore SJ, Frith U. The learning brain: lessons for education: a précis. Dev Sci. 2005;8(6):459-65. doi: 10.1111/j.1467-7687.2005.00434.x.
10. Fischer KW, Goswami U, Geake J. The future of educational neuroscience. Mind Brain Educ. 2010;4(2):68-80. doi: 10.1111/j.1751-228X.2010.01086.x.
11. Gardner H. An education grounded in biology: interdisciplinary and ethical considerations. Mind Brain Educ. 2009;3(2):68-73. doi: 10.1111/j.1751-228X.2009.01056.x.
12. Pickering SJ, Howard-Jones P. Educators' views on the role of neuroscience in education: findings from a study of UK and international perspectives. Mind Brain Educ. 2007;1(3):109-13. doi: 10.1111/j.1751-228X.2007.00011.x.
13. Tokuhama-Espinosa TN. The Scientifically Substantiated Art of Teaching: A Study in the Development of Standards in the New Academic Field of Neuroeducation (Mind, Brain, and Education Science) [dissertation]. Minneapolis, Minnesota: Capella University; 2008.
14. Thomas MSC, Ansari D, Knowland VCP. Annual research review: educational neuroscience: progress and prospects. J Child Psychol Psychiatry. 2019;60(4):477-92. doi: 10.1111/jcpp.12973.
15. Nouri A. Curriculum Biology Basics. Curriculum Encyclopedia; 2014. [Persian].
16. HHoward Jones, Powell. Educational Sciences and Brain: Introduction to Educational Neurological Research, london: New York: Routledge, 2010.
17. Rezazadeh Mottaghi N, Talkhabi M. Comparative study

of Iran and the UK national curriculum based on the principles of mind, brain and education. J Curric Stud. 2019;8(1):46-57. doi: 10.5430/jct.v8n1p46.
18. Fauzi A. Demystify Civic Education through the Educational Neuroscience on Indonesia Curriculum. Availabe from: https://www.atlantis-press.com/proceedings/acec-18/25905910. Accessed September 19, 2020
19. Hassani M, Dastjerdi R. Pakdaman M. The effect of brain-based learning (BBL) on attitude & academic achievement of students in mathematic. Curriculum Planning Knowledge & Research in Educational Sciences. 2016;12(47):61-73. [Persian].
20. Zadina JN. The emerging role of educational neuroscience in education reform. Psicol Educ. 2015;21(2):71-7. doi: 10.1016/j.pse.2015.08.005.
21. Samadi M. The Effectiveness of Brain-Based Education on Improving Mathematical Performance of Students with Fifth Grade Mathematical Learning Disability in Isfahan Elementary School: A Single Case Study [thesis]. University of Esfahan; 2013. [Persian].
22. Abdi A, Ahmadian H. Evaluating the Effectiveness of Brain-Based Education on Academic Achievement Among Elementary Fifth Grade Students in Experimental Science Course. First National Conference on Cognitive Science Findings in Education; 2011. Iran, Ferdowsi University of Mashhad. p. 619-27. [Persian].
23. Sharifi z, Fathiazar E, Mani A , Adib Y. Designing a curriculum model based on cognitive neuroscience and its impact on executive functions and academic achievement of students with mathematical learning disabilities in Shiraz. PhD Thesis. Tabriz University; 2020.
24. Abedi A. Investigation of effectiveness of neuropsychological interventions for improving academic performance of children with mathematics learning disabilities. Advances in Cognitive Science. 2010;12(1):1-16. [Persian].
25. Narimani M, Soleymani E. The effectiveness of cognitive rehabilitation on executive functions (working memory and attention) and academic achievement in students with math learning disorder. Journal of Learning Disabilities. 2013;2(3):91-115. [Persian].
26. Faramarzi S, Sadri S. The effect of basic neuropsychological interventions on performance of students with dyscalculia. Neuropsychiatria i Neuropsychologia. 2014;9(2):48-54.
27. Sharifi T, Rabiei M. The use of the fourth edition of the Wechsler IQ test for the diagnosis of written and mathematical disorder. Journal of Learning Disabilities. 2012;2(2):59-75. [Persian].
28. Narimani M, Soleymani E, Tabrizchi N. The effect of cognitive rehabilitation on attention maintenance and math achievement in ADHD students. Journal of School Psychology. 2015;4(2):118-34. [Persian].
29. Sadeghi Z, Behrangi M, Abdollahi B, Zeinabadi H. The effect of education management based on strategies of educational neuroscience on student' learning improvement. Education Strategies in Medical Sciences. 2016;9(2):97-105. [Persian].
30. Özdemir AÞ, Sadýk S. The effect of mathematic education, which is based on brain based learning theory, on academic success and attitude. Eurasian Education & Literature Journal. 2015;3(3):1-18. doi: 10.17740/eas.edu.
31. Taraj M. Comparison of the Effectiveness of Brain-Based Learning Strategies and Cognitive-Metacognitive Strategies on Improving Mathematical Performance of Elementary Third-grade Female Students in Urmia [dissertation]. Urmia: Urmia University; 2012. [Persian].
32. O'Connor WT. What Can Neuroscience Teach Us about Teaching? Maynooth, Ireland: Internaitonal Conference on Engaging Pedagogy (ICEP); 2010.
33. Meyer ML, Salimpoor VN, Wu SS, Geary DC, Menon V. Differential contribution of specific working memory components to mathematics achievement in 2nd and 3rd graders. Learn Individ Differ. 2010;20(2):101-9. doi: 10.1016/j.lindif.2009.08.004.