The University of Tehran Press

Journal of Cognitive Science Research

2025, 1(3), 32-46

Home Page: https://jcsr.ut.ac.ir/

Online ISSN: 3092-6777

The Effect of Self-Regulatory Education Based on the SRSD Model on Executive Function in Children with Learning Disabilities in Math and Writing Problems

Niloofar Aghaeinejad [1], Zahra Naghsh [2*], Sogand Ghasemzadeh [3], Alireza Najimi [4]

1. Department of Psychology, Faculty of Humanities and Social Sciences, University of Mazandaran, Babolsar, Iran.
2. Department of Educational Psychology, Faculty of Psychology and Education, University of Tehran, Tehran, Iran.
3. Department of Psychology and Education of Exceptional Children, Faculty of Psychology and Educational Sciences, University of Tehran, Tehran, Iran.
4. Department of Biostatistics, Faculty of Medical Sciences, Isfahan University of Medical Sciences, Isfahan, Iran.

***Corresponding Author:** Associate professor, Department of Educational Psychology, Faculty of Psychology and Education, University of Tehran, Tehran, Iran. Email: z.naghsh@ut.ac.ir

ARTICLE INFO

Article type:
Research Article

Article History:
Received: 12 Feb 2025
Revised: 02 Jun 2025
Accepted: 01 Jul 2025
Published: 01 Oct 2025

Keywords:
Self-regulatory education program, SRSD-based self-regulatory education, Executive function, Children with learning disabilities.

ABSTRACT

Backgrounds: Children with learning disabilities are children who are weak in one or more basic psychological processes. Executive function is one of the important cognitive processes that play an important role in academic performance. Objectives: In this regard, the present study aimed to prepare a self-regulatory education program based on SRSD and investigate its effectiveness on executive function, Cognitive-Learning content areas and academic achievement of children with learning disabilities. Methods: The present study is a semi-experimental study with pre-test and post-test .sample of 30 children with learning disabilities in Gorgan, including 15 in the control group, and 15 in the experimental group was selected. The instruments used in this study included LEAF scale (2016) and WISC-IV (2003), which was implemented and scored in two stages, before and after the self-regulation training program based on SRSD. Data analysis was performed using multivariate variance analysis using SPSS software version 26. The $P<0.05$ were considered for data analysis and as significant levels respectively. Results: The results of multivariate variance analysis showed self-regulatory education has been able to reduce weaknesses in Cognitive-Learning content areas (Comprehension and Conceptual Learning) ($p<0.001$), executive function components (Factual Memory, Attention, Visual-Spatial Organization, Sustained Sequential Processing, Working Memory, Novel Problem Solving)) ($p<0.001$), academic achievement (Mathematics Skills, Basic Reading Skills, Written Expression Skills) ($p<0.001$) and promote the components in these children. Conclusion: The findings of this study show that educational program can be effective in improving cognitive learning content, executive function components, and academic achievement in children with learning disabilities.

Cite this article: Aghaeinejad, N., Naghsh, Z., Ghasemzadeh, S., & Najimi Varzaneh, A. (2025). The Effect of Self-Regulatory Education Based on the SRSD Model on Executive Function in Children with Learning Disabilities in Math and Writing Problems. *Journal of Cognitive Science Research*, *1*(3), 32-46. doi:10.22059/jcsr.2025.390426.1007

Publisher: University of Tehran Press
DOI: https://doi.org/10.22059/jcsr.2025.390426.1007

Introduction

Learning disability includes problems with poor reading, poor writing, and math disorders, and refers to a disorder in one or more basic psychological processes related to understanding or using spoken or written language. The disorder may manifest as problems with the ability to listen, think, speak, read, write, or do math calculations. In the diagnostic manual of mental disorders, learning disabilities are classified as dyslexia, dyslexia, and math disorder. (Association AP, 2015)

Children with learning disabilities have problems in their other functions due to malfunctioning of the nervous system, differences in psychological processing, and defects in information processing. Mathematical disorder causes problems in solving problems and calculations using inappropriate strategies appropriate to the problem, and problems in learning and remembering mathematical concepts (Arslani et al., 2019)

Writing disorder is a category of learning disorder that causes problems in the cognitive processing and writing skills of a person. A person with a written learning disorder has problems in auditory processing content processing and rapid automatic naming. (Sangani, war, Priya, ramek, 2019) One of the problems of children is problems in executive functions. Executive functions are complex cognitive processes that create purposeful behavior and are usually associated with disorders and are one of the influential areas of executive function weakness (Hosseinidashtbayaz et al., 2020).

Dowson & Guare (2004) consider executive functions to include 5 skills, including planning skills that create a plan to achieve a goal or complete a task, The power to organize includes making decisions and recognizing important and unimportant matters, designing and maintenance of information and time management, working memory, which includes storing information in memory while working, and self-monitoring skills (Dowson, McInerney, 2004)

This function includes all the cognitive skills that help a person to pay attention focus and perform activities, therefore this function is effective in the academic progress of people (McClelland, Cameron, 2019) Children with learning disabilities are a group of children whose executive functions are in trouble, and weakness in this function impairs their reading, writing, and math skills (Babaei et al., 2012). Executive function is an effective factor in math learning and one of the causes of children's math problems is their weak executive function (Arshad, kasheffi, 2021). Also, executive function affects writing, and one of the factors affecting writing disorder is weakness in executive functions (Hadi et al., 2017)

Operationally, executive function is the score that children get on the scale of executive function, attention, and learning function (Castellanos et al., 2016)One of the factors affecting children's executive functioning is the use of self-regulation training (Mansour, 2013)

Self-regulation training makes children learn self-regulation strategies. The use of these strategies causes the child to have self-control over the learning process and start planning, organizing, and monitoring, if a strategy is not effective, change it, and in this way, it can affect the executive function (Ebrahimi, 2019) Self-regulation training is a factor that helps people to use self-control, self-assessment, planning, and monitoring skills in different stages of learning and become self-regulation learners (Neemchahi et al., 2018)

In the last decade, the approach that has evolved in the field of cognitive and metacognitive skills is the self-regulation approach. Self-regulated learning training causes people to increase their learning, understanding, and concentration by using appropriate cognitive and metacognitive strategies, and as a result of this, their anxiety decreases, and their emotional self-efficacy increases. Also, by learning this skill, learners can pursue assignments and have a good performance in solving problems. (Ghasemi et al., 2015)

Self-regulated strategy development (SRSD) is an evidence-based method for children with learning disabilities (Baker et al., 2015) Cognitive strategy training is specific to academic skills

that are focused on training (Rogers, Hodge, Counts, 2020). SRSD is an educational framework that is effective for students with learning disabilities or students who are prone to failure or difficulty in writing, reading skills, and mathematics (Hagaman et al., 2016)

SRSD includes training methods that solve executive function problems and specifically, SRSD affects the components of decision-making and planning, implementation and coordination of mental and emotional resources, attention control, and flexible adaptation (Harris et al., 2018)

The self-regulation training program is a program that helps people first learn about various self-regulation strategies, then internalize those strategies and use them independently by discussing and practicing various issues and activities. The SRSD framework includes explicit instruction, cognitive strategy instruction, self-regulation instruction, and recall to help children remember the steps of a process.

In the current research, the SRSD model is taught to children in the form of 6 stages, in the order of development of background knowledge, discussion, and discussion, modeling of the model, retention of strategies, support for it, and independent performance of the child.

Research results show that self-regulation training has an effect on children's executive function, and executive function plays an important role in children's learning disorders, and strengthening it has a positive effect on learning disorders. However, so far, there has been no study investigating the effectiveness of self-regulation training based on the SRSD model and investigate its effectiveness on learning, executive function, and academic skills of children with learning disabilities. In line with this main goal, this study sought to answer the following questions:

1. Is self-regulation training based on the SRSD model effective on the cognitive subscale of learning in children with learning disabilities?
2. Is self-regulation training based on the SRSD model effective on the subscale of cognitive executive function in children with learning disabilities?
3. Is self-regulation training based on the SRSD model effective on the subscale of academic skills in children with learning disabilities?

Method

Research Design

The present study was semi-experimental applied research of pre-test and post-test type with a control group consisting of 30 children with learning disabilities in Gorgan city. The sampling method in this research was a non-random sampling of the available type. The tools used in this research include the learning scale, executive function, and attention of Castellano, Kronberger, and Pisoni (2013) the fourth version of the Wechsler intelligence scale (2003) for children.

After interviewing and evaluating children using the Wechsler scale determining the normality of their intelligence (IQ score of at least 70±5)and diagnosing learning disorders in them through the learning scale, executive function, and attention, children with weakness in executive function were identified .The design of the study was carried out according to self-regulation education, including the stages of developing background knowledge, discussion, and dialogue, modeling it, maintaining strategies, supporting the child to follow it, and performing the child's independent performance.

This study has an ethics code to ID (IR.UT.PSYEDU.REC.1401.072) from the Faculty of Psychology and Educational Sciences, University of Tehran. Among the ethical principles respected, the confidentiality of information, voluntary withdrawal from the research, and no harm to the participants.

Sample of the Study

The population of this study was all children with specific learning disorders who were referred to Hekmat Learning Disorders Center in the academic year of 1401-1400 in Gorgan city. 30 male children including 15 in the control group, 15 in the experimental group in the age range of 8 to 12 years in the manner available sampling was selected (Table 1).

The criteria for entering the research include consent of parents and children to participate in the research based on written consent, male students between the ages of 8 and 12, children with specific learning disabilities,(Dysgraphia , and Dyscalculia), and children who have weaknesses in our executive functions (according to the learning, executive function, and attention scale questionnaire, the range 5-15)The criteria for the withdrawal of participants from the research included: non-cooperation and unwillingness of the participants to continue the sessions, absence of more than two sessions in the training sessions, and history of receiving psychological interventions related to the problem.

Table 1. Characteristics of the research sample

Group	Disorder	Frequency
Treatment	Math And Writing Disorder	15
Control	Math Disorder	2
	Math And Writing Disorder	13

Data Collection Instruments and Methods

The scale of learning, executive function, and attention:

In this study, the scale of learning, executive function, and attention was used to measure executive function and learning skills in children and adolescents aged 7 to 17 years, which was designed by Castellano, Kronberger, and Pisoni (2013) This scale includes two parts of cognitive-learning content; which includes the skill of learning, memory, and reasoning, which are close and related to executive function but are not part of the basic structure for executive function. Two subscales of cognitive content learning are the executive function scale, attention function, and learning. 1 item was considered for each factor and as a result, 11 items were created. Items were rated on a 0-3 Likert scale; by summing the 5 items related to each 11 subscales, a total score of 55 is obtained, so higher scores indicate more problems (Faries, et al., 2001)

A rating of 2 (often) is used for behaviors that cause problems, while option 1 (sometimes) reflects behaviors that may occur more than average but do not cause a major problem; Therefore, the average scores related to choosing option 2 for the five items of each subscale show that the behaviors related to that subscale occur more than average and happen almost every day and cause problems. Also, in the scale of executive functioning, attention, and learning, 3 criteria were considered to interpret problems .Cronbach's alpha coefficients for executive function scale, attention, and learning function and its subscales, respectively, 0.88, 0.91, 0.85, 0.71, 0.79, 0.80, 0.70, 0.82, 0.93, 0.89, 0.77 were obtained, which indicates high internal consistency. to check the reliability of the Persian version of the executive functioning scale, performance, and stability of attention and learning, two methods of internal consistency were used. In examining the internal consistency of the scale, Cronbach's alpha was calculated and its validity and reliability were confirmed in research (farzadi et al., 2020) Test-retest reliability results for subscales are 0.41, 0.71, 0.82, 0.86, 0.89, 0.72, 0.85, 0.63, 0.82, 0.88 respectively. 0.79 was obtained.

The differential validity and discrimination power of the scale were used by comparing the subscales in terms of two age groups using the independent two-group Test-T method. To check the criterion validity, the scale of executive function, attention, and learning performance with the rating of executive function behavior, as well as neuropsychological tools of executive functions (Simon's color word test and homework)(nejati et al.,2021) and Woodcock Johnson's academic achievement test was used. The results of the research show that the cognitive

learning subscale of the executive function scale, attention and learning performance, are correlated with the attention problems subscale of the shortened scale of hyperactive behavior and attention problems and disobedience symptoms and the executive function behavior rating subscales.

The fourth version of the Wechsler intelligence scale for children:

The fourth edition of Wechsler's Children (2003) can measure the intelligence of children in the age range of 6 to 16 years and 11 months. This tool has 15 sub-tests which are divided into two groups of main and substitute sub-tests. The mean of each subtest is 10 and its standard deviation is 3. Also, the fourth version of the Wechsler IQ scale can measure intelligence, verbal comprehension, perceptual reasoning, active memory and processing speed, verbal comprehension, executive reasoning, verbal reasoning, active memory, and processing speed with a mean of 100 and a standard deviation of 1 (Farid et al.,2015) From the total of ten sub-tests of these four scales, the IQ of the whole test can be calculated. This test was translated, adapted, and standardized in 2016 by Abedi, Sadeghi, and Rabiei with the financial support of Chaharmahal and Bakhtiari Education Organization. The reliability coefficients of the subtests are reported by Cronbach's alpha (between 0.65 and 0.94) and also by the halving method between 0.76 and 0.91. The validity of the test has been reported at a favorable level through simultaneous implementation with Wechsler, Shahim, and Riven. All reliability coefficients are more than 0.7, which indicates the reliability of the test (Tayyaba, Mohammad, 2013)

Experimental Application Process

The research design was considered by studying the theoretical and experimental backgrounds in this field. Programs already designed for self-regulation training were also reviewed to consider their strengths. The lesson plan for each session, educational tools, pamphlets, and children's homework were set. First, to enter the Hikmat Learning Disorders Center in Gorgan City, an introduction letter from the university was delivered to the center's management, and with the cooperation of the Gorgan Learning Disorders Centers and with their consent, access to the samples was possible.

First, to enter the Hikmat Learning Disorders Center in Gorgan City, an introduction letter from the university was delivered to the center's management, and with the cooperation of the Gorgan Learning Disorders Centers and with their consent, access to the samples was possible . After selecting the samples using the available sampling method and selecting the children with learning disabilities by performing the Wechsler children's test and diagnostic interview and diagnosis of learning disabilities, they were divided into two groups of 15 people and were placed in the control and experimental groups.

Before the start of the training, the executive function and attention questionnaire of Castellano et al(۱۰)was implemented and scored, and after the implementation of the self-regulation training program based on SRSD, the executive function and attention questionnaire of Castellano et al. was implemented and scored again. The intervention was in the form of an educational program and the formation of a class for the participants. The development of the intervention program was also under the supervision of experts.

The validity of the program was reviewed and approved by experts and corrections were made. This research is based on the previous research of Sohrabi et al., (2014); Seydi et al. (2021) ; Wanzek et al.(2021) ; Stevens et al.(2021) ; it was done in groups and groups of 2 or 3 people, and the intervention was done for 12 sessions and in 6 weeks of 2 sessions.

Reliability Analysis of the Scales

To check the validity of the content, a copy of the self-regulation training program along with a checklist was prepared with the aim of checking the theoretical suitability and behavioral examples and was given to 5 experts in this field to rate the suitability of each intervention session on a Likert scale (from 1, the lowest suitability to 10, which is the most suitable for the

program). The formal and content validity of the presented model was calculated using the content validity index (CVI) (Table 2).

Table 2. Content Validity Index Based on Judges' Opinions

Judges	Meetings												Mean
	1	2	3	4	5	6	7	8	9	10	11	12	
1	8	9	10	9	9	7	8	9	10	9	8	8	8.66
2	5	6	7	7	5	3	4	5	6	6	7	6	5.58
3	9	9	8	9	9	9	9	9	9	8	9	9	8.83
4	6	6	7	8	7	8	9	8	9	9	10	9	8
5	6	7	7	7	7	7	6	7	7	8	7	6	6.83
Mean	6.8	7.4	7.8	8	7.4	6.8	7.2	7.6	8.2	8	8.2	7.6	

Data Analysis

After collecting pre-test and post-test data, the collected data were analyzed with statistical tests. In this research, descriptive statistics such as frequency, mean, and standard deviation, and inferential statistics including multivariate covariance analysis were used to control the pre-test variable, and the data analysis software was SPSS version 24.

Results

Table 3 shows the frequency of people in two pre-test and post-test groups who were placed in two control and experimental groups. In Table 4, information about the number of participants in the two control and experimental groups and information about the age groups present in the sample is given. (Table 3, 4)

Table 3. The Frequency of People in the Control and Treatment Groups in Two Stages of Measurement

Group	Pre-Test	Post-Test	Total
Treatment	15	15	30
Control	15	15	30
Total	30	30	

Table 4. Frequency related to class age groups of sample people

Class age group	Treatment		Control	
	Frequency	Percent	Frequency	Percent
Third grade	2	0.13	1	0.06
fourth grade	6	0.4	1	0.06
Fifth grade	5	0.33	7	0.46
6th grade	2	0.13	6	0.4

In Table 5, the descriptive statistics related to the mean and standard deviation of the scores of the executive function components for the individuals of the control and experimental groups are given separately in two stages of measurement. In the control group, the average scores in the pre-test and post-test stages did not change much, but in the experimental group, we saw a significant decrease in the post-test scores compared to the pre-test, and it shows that the degree of weakness in the components of executive function has decreased in the post-test scores. Also, in the follow-up phase, the scores of the control group increased slightly, but in the experimental group, the scores decreased, indicating a decrease in the degree of weakness in the executive function components in the follow-up phase. (Table 5)

Table 5. The mean and standard deviation of the scores of executive function components in the two stages of the test, separately for the treatment and control group

Group	Variable	Pre-test Mean	Pre-test SD	Follow-up Mean	Follow-up SD	Post-test Mean	Post-test SD
Control	Understanding learning	7.33	1.45	7.25	1.48	8.48	1.34
	Real memory	7.92	1.67	6.90	1.42	7.36	1.70
	Attention	8.27	1.81	7.17	1.24	7.88	1.52
	Processing speed	7.13	1.27	7.47	1.36	7.96	1.75
	Visual organization	7.63	2.20	6.80	1.57	7.86	1.56
	Stable sequential processing	8.05	1.98	6.93	1.33	6.98	1.34
	Working memory	8.65	1.45	7.47	1.06	8.77	1.00
	New problem solving	8.10	1.83	7.13	1.13	8.13	1.46
	Math skills	8.46	1.48	7.92	1.18	8.24	1.13
	Basic reading skills	8.76	1.35	7.20	0.86	7.89	0.89
	Written expression skills	8.10	1.99	7.07	1.44	7.96	1.49
Treatment	Understanding learning	9.13	3.48	5.34	3.13	4.32	3.12
	Real memory	9.18	3.74	5.87	4.05	4.09	3.08
	Attention	9.81	2.91	6.64	3.39	6.04	3.13
	Processing speed	6.59	3.34	7.00	4.14	6.56	3.15
	Visual organization	9.36	3.15	5.80	3.28	5.00	3.27
	Stable sequential processing	9.20	3.73	5.67	4.55	5.45	3.51
	Working memory	10.41	2.98	6.40	3.79	6.02	3.84
	New problem solving	9.76	3.25	5.47	3.56	4.67	3.35
	Math skills	10.36	2.82	6.24	3.21	5.23	3.05
	Basic reading skills	9.77	3.99	5.67	4.50	4.45	3.80
	Written expression skills	9.27	3.98	4.07	3.58	3.06	3.05

In this section, the assumptions are tested primarily for the analysis of the data. Then, answers were given to the research problems in order.

1. Self-regulation training program based on SRSD affects the cognitive subscale of learning.

To investigate the effectiveness of the self-regulation program based on SRSD on the cognitive subscale of learning, the multivariate analysis of covariance (MANCOVA) test was used. Before performing this test, it is necessary to check some statistical assumptions. One of the assumptions of the multivariate covariance analysis test is the homogeneity of the covariance matrix, and the Box's M test was used to check the establishment of this assumption. The results of this test are shown in (Table 6)

Table 6. The result of homogeneity of the covariance matrix for cognitive learning subscale (Box's M)

Box's M	F	df1	df2	p-value
131.04	1.44	55	2531.77	0.018

As can be seen in Table 6, the significance level of the box test is equal to 0.018. Since this value isnt greater than the significance level (0.05) needed to reject the null hypothesis, our assumption of the homogeneity of the covariance matrix isnt confirmed. This is one of the limitations of the research.Another assumption of the multivariate covariance analysis test is to check the normality of the pre-test and post-test score distribution, and the Kolmogorov-Smirnov test was used to check the establishment of this assumption. The results of this test are shown in (Table 7).

Table 7. Kolmogorov-Smirnov test results to check the normality of the distribution of scores

Variable	Pre-Test		Post-Test	
	Kolmogorov-Smirnov	p-value	Kolmogorov-Smirnov	p-value
Understanding learning	0.138	0.148	0.113	0.200
Real memory	0.133	0.186	0.117	0.200

p<0/05

Table 7 shows the results of the Kolmogorov-Smirnov test to check the normality of the distribution of pre-test and post-test scores. Based on the results in the table, the significance level of the calculated statistic is greater than 0.05, so the assumption of normal distribution of scores is accepted. Another assumption of covariance analysis is to check the slope of the regression line, the results of which can be seen in (Table 8)

Table 8. Homogeneity of the slope of the regression line

Variable	SS	df	MS	F	P-Value
Understanding learning	0.002	1	0.002	0.002	0.96
Real memory	1.59	1	1.59	0.82	0.37

p<0/05

Table 8 shows the results of the F test to check the homogeneity of the slope of the regression line. Based on the results in Table, the significance level of the calculated statistic is greater than 0.05, so the assumption of homogeneity of the slope of the regression line is rejected and the slope of the regression line for the scores of the intervention and control groups is not homogeneous about the dependent variable, and this assumption has also been observed. (Table 9)

Table 9. The Results of Multivariate Covariance Analysis to Compare the Learning Cognitive Subscale in Treatment and Control Groups

Effect	Test	Value	F	df1	df2	P-Value
Group	Pillai	0.66	3.06	11	17	0.019
	Wilks Lambda	0.33	3.06	11	17	0.019
	Hotelling	1.98	3.06	11	17	0.019
	Roy	1.98	3.06	11	17	0.019

p<0/05

As can be seen in Table 9, the significance level of all four multivariate statistics is less than 0.05 (p<0.05). Therefore, the statistical null hypothesis is rejected, and it is determined that there is a significant difference between the executive function variables in the two experimental and control groups. So, self-regulation training based on SRSD affects the cognitive subscale of students' learning. To investigate the difference between the two experimental and control groups in each of the components of the cognitive subscale of learning, the between-subjects effects test was used, and the results are presented below .(Table 10)

Table 10. The test of inter-subject effects to compare the components of the cognitive learning subscale of the experimental and control groups in the post-test

Variable	Source	SS	df	MS	F	p-value	Effect size
Understanding learning	between groups	65.91	1	65.91	65.33	0.001	0.7
	within group	27.23	27	1.009			
Real memory	between groups	34.76	1	34.76	17.96	0.001	0.4
	within group	52.25	27	1.93			

Table 10 shows the results of the between-subjects effects test to compare the components of the cognitive subscale of learning in the subjects of the experimental and control groups in the post-test phase. According to the presented results, the obtained F value is significant for all components. Therefore, the null hypothesis which states that the self-regulation training component based on SRSD does not affect the cognitive subscale of learning is rejected in all components and the research hypothesis is confirmed. Considering the higher average scores of the experimental group in the post-test stage, it is concluded that the self-regulation program is effective on all the components of the cognitive subscale of children's learning and strengthens understanding and real memory in children

2. Self-regulation training program based on SRSD affects the subscale of cognitive executive function.

The results of the Kolmogorov-Smirnov test to check the normality of the distribution of pre-test and post-test scores are given in Table 11. Based on the results of the table, the significance level of the calculated statistic is greater than 0.05, so the assumption of normal distribution of scores is accepted (Table 11)

Table 11. The results of the Kolmogorov-Smirnov test to check the normality of the distribution of scores

Variable	pre-test		Post-test	
	Kolmogorov Smirnov	p-value	Kolmogorov Smirnov	p-value
Processing speed	0.131	0.2	0.13	0.16
Visual	0.131	0.19	0.12	0.2
Stable sequential processing	0.124	0.2	0.11	0.2
working memory	0.132	0.19	0.13	0.16
New problem solving	0.126	0.2	0.13	0.18
Attention	0.151	0.07	0.11	0.2

p<0/05

Table 12 shows the results of the F test to check the homogeneity of the slope of the regression line. Based on the results listed in Table 12, the significance level of the calculated statistic is greater than 0.05, so the assumption of homogeneity of the slope of the regression line is rejected, and the slope of the regression line for the scores of the intervention and control groups is not homogeneous about the dependent variable, and this assumption has also been observed. (Table 12)

Table 12. Homogeneity of the slope of the regression line

Variable	**Type Sum of Squares**	**df**	**Mean Square**	**F**	**p-value**
Processing speed	0.08	1	0.08	0.03	0.86
Visual	2.85	1	2.85	1.72	0.20
Stable sequential processing	14.35	1	14.35	6.77	0.02
Working memory	8.83	1	8.83	4.82	0.04
New problem solving	5.83	1	5.83	2.99	0.10
Attention	6.94	1	6.94	6.06	0.02

p<0/05

As can be seen in Table 13, the significance level of all four multivariate statistics is less than 0.05 (p<0.05). In this way, the statistical null hypothesis is rejected, and it is determined that there is a significant difference between the variables of cognitive executive function in the two experimental and control groups. So, self-regulation training based on SRSD affects students' cognitive executive function (Table 13)

Table 13. The results of multivariate covariance analysis to compare the cognitive executive function subscale in the experimental and control groups

Effect	**Test**	**Value**	**F**	**Df1**	**Df2**	**P-Value**
Group	Pillai	0.66	3.061	11	17	0.019
	Wilks Lambda	0.33	3.061	11	17	0.019
	Hotelling	1.98	3.061	11	17	0.019
	Roy	1.98	3.061	11	17	0.019

To investigate the difference between the two experimental and control groups in each of the components of the cognitive executive function subscale, the between-subjects effects test was used, and the results are presented below (Table 14).

Table 14. The test of inter-subject effects to compare the components of the cognitive executive function of the experimental and control groups in the post-test

Variable	**Source**	**SS**	**Df**	**MS**	**F**	**P-Value**	**Effect Size**
Processing speed	between groups	0.08	1	0.08	0.03	0.85	0.001
	within group	66.26	27	2.45			
Stable sequential processing	between groups	41.78	1	41.78	16.23	0.001	0.379
	within group	69.47	27	2.57			
New problem solving	between groups	63.9	1	63.9	30.53	0.001	0.53
	within group	56.51	27	2.09			
Attention	between groups	26.84	1	26.84	19.72	0.001	0.42
	within group	36.74	27	1.36			
Visual	between groups	39.46	1	39.46	23.19	0.001	0.46
	within group	45.93	27	1.7			
working memory	between groups	53.36	1	53.36	25.53	0.001	0.48
	within group	56.42	27	2.09			

Table 14 shows the results of the between-subjects effects test to compare the components of the cognitive executive function subscale in the subjects of the experimental and control groups in the post-test phase. According to the presented results, the obtained F value is significant for all components except processing speed. Therefore, the null hypothesis, which states that the self-regulation training component based on SRSD does not affect the subscale of cognitive executive function, is rejected in all components except processing speed, and the research hypothesis is confirmed. Considering the higher average scores of the experimental group in the post-test phase, it is concluded that the self-regulation program is effective on all the components of the subscale of children's cognitive executive function, except processing speed, and it strengthens this subscale in children.

3. Self-regulation training program based on SRSD affects the subscale of scientific academic skills

Table 15. The results of the Kolmogorov-Smirnov test to check the normality of the distribution of scores

Variable	pre-test		post-test	
	Z Kolmogorov Smirnov	P-Value	Z Kolmogorov Smirnov	P-Value
Math Skills	0.117	0.200	0.121	0.2
Basic Reading Skills	0.134	0.177	0.150	0.08
Written Expression Skills	0.143	0.119	0.156	0.06

p<0/05

(Table 15) shows the results of the Kalmogorov-Smirnov test to check the normality of the distribution of pre-test and post-test scores. Based on the results listed in the table, the significance level of the calculated statistic is greater than 0.05, so the assumption of normal distribution of scores is accepted. (Table16)

Table 16. Homogeneity of the slope of the regression line

Variable	SS	df	MS	f	p-value
math skills	3.094	1	3.094	1.107	0.302
Basic reading skills	6.576	1	6.576	4.357	0.05
Written expression skills	1.008	1	1.008	0.667	0.421

p<0/05

Table 16 shows the results of the F test to check the homogeneity of the slope of the regression line. According to the results of the table, the significance level of the calculated statistic is greater than 0.05, so the assumption of homogeneity of the slope of the regression line is rejected, and the slope of the regression line for the scores of the intervention and control groups is not homogeneous about the dependent variable, and this assumption is also met. (Table 17)

Table 17. The results of multivariate covariance analysis for the comparison of the subscale of scientific academic skills in the experimental and control groups

Effect	Test	Value	F	Df1	Df2	P-Value
Group	Pillai	0.66	3.061b	11	17	0.019
	Wilks Lambda	0.33	3.061b	11	17	0.019
	Hotelling	1.98	3.061b	11	17	0.019
	Roy	1.98	3.061b	11	17	0.019

p<0/05

As can be seen in Table 17, the significance level of all four multivariate statistics is less than 0.05 (p<0.05). In this way, the statistical null hypothesis is rejected, and it is determined that there is a significant difference between the variables of the academic skills subscale in the two experimental and control groups. Therefore, self-regulation training based on SRSD affects the subscale of students' academic skills. To investigate the difference between the two experimental and control groups in each of the components of the subscale of academic skills, the between-subjects effect test was used, the results of which are presented below.(Table18)

Table 18. Test of intersubject effects to compare the components of the subscale of scientific academic skills of the experimental and control groups in the post-test

Variable	Source	SS	Df	MS	F	P-Value	Effect Size
Basic reading skills	between groups	47.04	1	47.04	27.76	0.001	0.5
	within group	45.75	27	1.69			
Written expression skills	between groups	110.3	1	110.03	73.89	0.001	0.73
	within group	40.3	27	1.39			
math skills	between groups	63.26	1	63.26	22.55	0.001	0.45
	within group	75.72	27	2.8			

Table 18 shows the results of the between-subjects effects test to compare the components of the subscale of academic skills in the subjects of the experimental and control groups at the post-test stage. According to the presented results, the obtained F value is significant for all components. Therefore, the null hypothesis, which states that the self-regulation training component based on SRSD does not affect the subscale of academic skills, is rejected in all components, and the research hypothesis is confirmed. According to the higher average scores of the experimental group in the post-test stage, it is concluded that the self-regulation program is effective on all the components of the subscale of children's scientific academic skills and strengthens these skills in children.

Discussion and Conclusion

The present study was conducted to prepare a self-regulation training program based on SRSD and investigate its effectiveness on learning, executive function, and academic skills of children with learning disabilities.

Children with learning disabilities are a group of children who have problems in the field of learning. These children have problems understanding materials and memory, and self-regulation training is one of the ways that can affect these components, and the results of the research show that self-regulation training based on The SRSD model can affect the components of understanding and memory and develop those components in these children. The research results are the research of Babaei et al. (2017); Rahbarkarbasdehi et al.(2019) ; Hosni Zanzibar and Livarjani (2017).

Self-regulation training based on SRSD provides conditions for people to learn cognitive and metacognitive strategies and use those strategies in appropriate conditions. People's learning depends on the use of cognitive and metacognitive strategies so the better the child uses strategies, the more learning takes place. Self-regulated learning provides conditions for people to monitor their learning process and learn when they understand and when they don't understand. The results of the research show that self-regulation training based on SRSD is effective on all components of the subscale of children's cognitive executive function, except processing speed, and it strengthens this subscale in children.The research results are by the researches of Ebrahimi and Taher (2019); Arghwani Pirsalami et al. (2017); Narimani et al.(2017); Zarenejad et al. (2019) and Ghasemi et al. (2021) . The results of the research showed that self-regulation training and its development will strengthen the foundations of perceptual skills and cognitive systems. The SRSD framework helps children consolidate skills learned in self-regulation education. Teaching self-regulation by introducing children to a variety of

cognitive and metacognitive strategies helps them to use these strategies, and using these strategies makes them become active learners.

Self-regulation training allows learners to carry out their academic activities by organizing, planning, and monitoring, and to review their failures to know self-regulation strategies, and to choose those strategies and make decisions according to the conditions. Self-regulation training allows learners to effectively start new assignments and use other strategies, and during this process, manage time organize their activities, and develop their executive function components. It can also be said that self-regulation training provides the basis for people to be more aware of their behaviors, and in this way, it causes more focus on behavior planning, and problem solving

The presence of this disorder in children causes them to gradually lose their self-efficacy toward academic performance and develop a negative attitude toward school and school activities. One of the effective activities that improve the academic skills of these children is self-regulation training based on the SRSD model. Self-regulation training allows learners to improve their math, reading, and writing skills by learning cognitive and metacognitive strategies and using them continuously in various activities based on the SRSD model. While using cognitive and meta cognitive strategies, learners become active learners who monitor and control their learning process choose strategies, and change them according to the conditions .The results of the research are in line with the research of Samadi (2004) and Moradi et al. (2009) who state that self-regulation training improves academic skills in students.

One of the limitations of the research is that It was impossible to select a random sample Because the subjects of the research sample were people who were referred to the Hikmat Learning Disorder Center, and for this reason, available sampling was used. The research used a questionnaire to evaluate executive function problems in children, which evaluates executive function based on parents' opinions, and parents' reluctance to answer honestly to the questionnaire is another limitation of the research.

It is suggested that to generalize the research findings, self-regulation training based on SRSD should be conducted on students from other cities and female students to ensure its applicability.This educational program can be implemented on hyperactive children and school students and compare the effects of this education in these groups. It is also suggested that in addition to the executive function questionnaire which is based on parents' opinions, a diagnostic tool should be used that is not influenced only by parents' opinions, and in future research, a program should be considered to check the durability of effectiveness in different time stages.

The results of multivariate covariance analysis showed that self-regulation training based on the SRSD model has an effect on the components of executive function except for processing speed, cognitive learning, and academic skills in children with learning disabilities, and also self-regulation training can reduce weakness in cognitive learning components (comprehension and comprehension, actual memory), executive function (attention, visual-visual organization, problem-solving, working memory, stable sequential processing), reduce academic skills (reading skills, math skills and writing skills) and improve the components in these children. The findings of the present study show that the educational program can be effective in

improving the cognitive learning components academic skills and executive function except for processing speed in children with learning disabilities.

Declarations

Author Contributions

First Author (NA): Conceptualization, Formal analysis, Investigation, Methodology, Writing - original draft, Writing - review & editing. Second Author (ZN): Collecting data, Resources, Formal analysis, Writing & reviewing. Third author (SGH): Investigation, Validation, Writing - review & editing. Fourth author (AN): Investigation, Validation, Writing - review & editing.

Data Availability Statement

Datasets used/analysed during the current study are available upon reasonable request.

Acknowledgements

We would like to thank all students that kindly participated in this study.

Ethical considerations

The Ethics committee of the University of Tehran approved this study under the ID number https://ethics.research.ac.ir/IR.UT.PSYEDU.REC.1401.072. All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Funding

The authors did not receive support from any organization for the submitted work.

Conflict of interest

The authors declare that there are no conflicts of interest regarding the publication of this research.

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