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Studing The Effectiveness of Integrative Instruction in the Executive Function, and the Collaborative for Academic, Social and Emotional learning on the General Mathematical performance: A Case Study of Female Students with Mathematical Learning Disability

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The purpose of this study was to investigate the effects of integrative instruction in the executive function and the Collaborative for Academic, Social and Emotional Learning (CASEL) on improving the mathematical performance of students with Mathematical Learning Disability (MLD). Semi-experimental method with pre-test and post-test control group design was applied in the current research. After screening (according to the checklist of DSMV-V, Raven test, and Key-Mat test), fourteen students were identified and randomly assigned to experimental and control group. The experimental group was given integrative instruction in 11 sessions while the control group did not receive any treatment. The data were analyzed with MANCOVA. The results showed that the integration of the two methods (executive function and CASEL) significantly increased the concepts and the applying dimensions of mathematical performance. Based on the findings of this study, it was suggested that educational psychologists apply the integration of two methods

of executive functions and CASEL teaching, to improve the performance of students with mathematical disabilities.

Keywords: math learning disability, executive functions, collaborative for academic social and emotional learning, mathematical performance

Learning Disability (LD) is known as a major learning problem which affects a person's daily activities. "LDs are specific patterns (subtypes) of neuropsychological assets and deficits that result in specific patterns of formal (e.g., academic) and informal (e.g., social) learning assets and deficits. LD may also lead to specific patterns of psychosocial functioning" (Rourke, 2005). According to Schulte-Korne, 2014, four sub-skills were found in the mathematics disorder, including: number sense, memorization of arithmetic facts, accurate or fluent calculation, and accurate mathematics reasoning. Other difficulties in mathematics disability are problem-solving, multi-step problems, verifying answers, recalling number facts, and borrowing/renaming errors (Bryant and Bryant, 2008). In the diagnostic and statistical manual of mental disorders (DSM 5), mathematics learning disability is defined as "the difficulties in mastering number sense, number facts, or calculation (e.g., having poor understanding of numbers, their magnitude, and relationships; counting on fingers to add single-digit numbers instead of recalling the mathematical facts as peers do; confusion in the midst of arithmetic computation and switchimg of procedures)" (American Psychiatric Association, 2013, p. 66).

Researchers revealed that MLD is associated with a deficit in the executive function (EF) of active memory (Bull, Espi & Wiebe, 2008). From the Neurological point of view, the executive functions (EF) are associated with an extensive network of frontal functions, and they include a large number of cognitive and

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metacognitive processes such as self-regulation of behavior, and the development of cognitive and social skills that are developed during child development period (Zelazo, et al., 2003).

Bull, et al. (2008) suggested that any defect in EF could lead to attention and concentration deficit, disruptions in planning to start and finish assignments, remembering assignments, retention of assignments, and even memory impairment and learning disabilities in children. Learning deficiencies are among the problems that can be significantly affected by weakness in EF.

EF is a higher cognitive function that is attributed to a set of logical abilities and is used as a term to describe cognitive processes that regulate thought and action (Friedman et al, 2006; Lezak, Howieson, Bigler & Tranel, 2012), such as; self-regulation, self-initiation, impulse control and monitoring of action, strategic planning (that is, the ability to mentally organize a set of conditions and steps to solving a problem), sequencing (that is, students' abilities to put events in order), prioritizing, selective and sustained attention, inhibition (the ability to hold back the current responses or restraining pre-potent responses), utilization of feedback, multi-tasking and shifting mental sets (changing a response through the activation of another response) and mental flexibility, perception of time, updating working memory and ability to deal with novelty (Chan, Shum, Toulopoulou & Chen, 2008; Miyake et al., 2000; Nigg, 2006; Friedman, et al. 2006; Lezak, Howieson, Bigler & Tranel, 2012).

One of the important aspects of EF is; a differentiation between hot and cool executive functions. Hot EF is required for problems that involve the regulation and motivation of basic limbic system functions, whereas, cool EF is more likely to be elicited by relatively abstract, decontextualized problems (Zelazo et al, 2003: 74). "Hot" affective aspects of EF is associated with

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orbitofrontal cortex; on the other hand, the more purely cognitive, "cool" aspects is associated with dorsolateral prefrontal cortex (Zelazo & Muller, 2002). Children's performance-based EF skills significantly affect the adjustment to the academic and behavioral demands (Jacobson, Williford & Pianta, 2011). It appears that hot EF can affect social competence, social behaviors, self-regulation and motivation of learner in the classroom, as EF, social behaviors and emotional functioning are associated jointly (Rourke, 2005). The combination of cool and hot executive functions can have good learning outcomes. Strengthening some of the executive functions, such as attention, concentration, and cognitive flexibility, and the simultaneous reinforcement of socio-emotional skills, provide a framework for the improvement of the learners' learning activities. The prior studies of intelligence, emotion, and social relations tended to be separate; but these phenomena were related to one another; for example, Piaget and Dewey had noted these interrelationships much earlier (Carillo, 2010). Based on what has been said, cognitive, emotional and social dimensions are interlinked in human development. Therefore, in this study, the effects of integration of executive functions (cognitive aspect) with the dimensions of social and emotional learning on mathematics performance were considered. The researchers found that the deficits in initiation and emotional EF, the organization in time abilities and emotional responses to impairments in organizing time, affect the quality of life of people with LD (Sharfi & Rosenblum, 2016). Toll, Van Der Ven, Kroesbergen & Van Luit (2011) showed that the working memory tasks could predict mathematical learning disabilities measures of EF and may be useful in identifying children who may experience difficulties in learning mathematical skills and concepts (Clark, Pritchard & Woodward,

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2010). Researchers revealed that visual short-term and working memory (especially visuospatial working memory), as well as inhibitory control can predict mathematical achievement at each time point (Bull et al., 2008; Espy et al., 2004; Bull & Scerif, 2001; St Clair-Thompson & Gathercole, 2006). For improving mathematical performance, a researcher supported the role of EF training (Mir Mahdi, Alizadeh & Saif Naraqi, 2009) and adaptive training which taxed working memory by playing computer games (Holmes, Gathercole & Dunning, 2009). Action video game playing may be used to enhance the ability to learn new tasks (Green & Bavelier, 2012). It appears that the active playing of video game may have positive effects on some executive functions (Buelow, Okdie & Cooper, 2015). Ke & Grabowski (2007), concluded that game playing was more effective than drills in promoting students' mathematics performance; and cooperative game playing was most effective for promoting positive mathematics attitudes regardless of students' individual differences. Furthermore, the game format had a facilitative effect on the continuing motivation of students who had low initial attitudes toward mathematics (Okolo, 1992). In addition to the role of the video game on promoting students' mathematics performance, based on past studies, social-emotional learning (SEL) also has an important role in increasing mathematical performance (McCormick, Cappella, O'Connor, & McCrory, 2015).

Social-emotional learning (SEL) is the process by which individuals achieve "the ability to understand, manage, and express the social and emotional aspects of one's life in ways that enable the successful management of life tasks such as learning, forming relationships, solving everyday problems, and adapting

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to the complex demands of growth and development" (Elias, et al. 1997).

SEL can foster: healthy decision-making, problem-solving, a safe, supportive learning environment, the improvement of social, health and ethical development, academic outcomes, and the motivation to achieve (Durlak, Weissberg, Dymnicki, Taylor & Schellinger, 2011; Greenberg et al., 2003; Zins, Elias & Greenberg, 2007). Such SEL is important to students because; emotions affect how and what they learn, and caring relationships provide a foundation for deep and lasting learning (Elias, Zins, Weissberg, et al., 1997). Latifi, Amiri, Malakpour, and Molavi (2009) in their study showed that cognitive emotional regulation and instruction of social problem solving through cognitive approaches can significantly improve the performance of students with learning disability, in terms of social problem solving, reduction of undesirable behaviors such as aggression, isolation, and modification of social goals.

The Collaborative for Academic, Social, and Emotional Learning identified a set of social-emotional skills that underlie effective performance of a wide range of social roles and life tasks (Elias, 2003: 9). CASEL's essential skills are: know yourself and others (identify feelings, take responsibility, recognize strengths); make responsible decisions (manage emotions, understand situations, set goals and plans, solve problems creatively); care for others (show empathy, respect others and appreciate diversity); know how to act (communicate effectively, build relationships, negotiate fairly, refuse provocations, seek help and act ethically) (Elias, 2003). Such competencies promote children's engagement in instructional activities and the classroom setting that in turn; enhance academic achievement (Eisenberg, Valiente & Eggum, 2010).

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CASEL describes SEL in terms of five domains of competence:

1. Self-Awareness: The ability to accurately recognize one's emotions and thoughts, and their influence on behavior. This includes accurately assessing one's strengths and limitations and possessing a well-grounded sense of confidence and optimism.
2. Self-Management: The ability to self-regulate emotions, thoughts and behaviors in different situations.
3. Social Awareness: The development of an empathic and respectful attitude towards people from different backgrounds and cultures.
4. Relationship Skills: The development of clear relationships, active listening, and participation; resistance against adverse social pressures, and systematic conflict resolution.
5. Responsible Decision-Making: The ability to create systematic and respectful opportunities with regard to individual behavior and social interactions and with consideration of ethnic standards, norms, and realistic assessment of the impact of different functions (CASEL Guide, 2013).

Based on Bandura's social cognitive theory, emotional and cognitive issues have the mutual influence on each other (Bandura, 1986). Hence, with regards to the problems caused by mathematical learning disabilities in the areas of academic, emotional and social skills for students (Freilich & Shechtman, 2010), it seems that CASEL as a program based-school, can improve students' mathematics academic performance as well as social and emotional competencies in students with mathematical learning disability. In addition, it seems that playing of video game via reinforcement of EF, can improve academic performance in MLD students.

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Therefore, the main purpose of the present study was to evaluate the combined effect of EF training and CASEL on improving the mathematical performance of female students with MLD.

Method

The present study was a semi-experimental research with a pretest, posttest and a control group design. The population included students of an elementary school in District 5 of Tehran in 1394. The sample consisted of 14 students who were randomly divided into an experimental group and a control group. In the sample selection, the students with learning disabilities were screened and randomly assigned to two groups. The screening took place in three stages. In the first stage, learning disability criteria determined in accordance with DSMV was explained to teachers and they were asked to choose students suspected of having a learning disability. In the next stage, the Raven IQ test was carried out on them and the students with normal IQ were identified. Afterward, the Iran Key Math test was conducted on these students; and the students whose score was 5.1 standard deviations below the mean, was identified. Finally, the experimental group was subjected to 11 sessions of executive functions and social-emotional training; but the control group received no training at all. In this study, only students from the third to fifth-grade elementary school were studied.

Instruments

Iran Key Math Test

The Iran Key math test is a criterion-referenced test that includes specific rules for the interpretation of norms. The test includes three sections of concept, operation, and application, in

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terms of scope. These sections are divided into three or four areas each which makes total of thirteen sub-tests. The overall mean and standard deviation of this test is equal to 100 and 15 respectively. Mohammad-Ismail & Hooman (2003) calculated the reliability of this test through Cronbach's alpha and got .80 to .84. Similarly, Yavari, Yaryary, and Rastegarpour (2007), reported that the reliability of this test through Cronbach's alpha is equal to .83.

Raven IQ Test

The Raven IQ Test was developed in the UK to measure the IQ of 9 to 18 years old children. The test includes 60 items (5 series of items each includes 12 sub-items). The internal consistency coefficient was obtained for .82. The Raven test's reliability obtained through test-retest method was equal to .61 (Bildiren, 2017). The instruments used to provide independent variable include:

Rehabilitation of Attention and Memory (ARAM)

This program is used for improving attention and working memory. The program is from Nejatis rehabilitation programs (2013, equated to najarzadegan, nejati, amiri & Sharifian, 2015). This program has 3 components:

A. "Home" computer game: this game is used to develop "continuous attention"

(B) "Face" Computer game: this game is used to develop "shifting attention"

(C) "Pack" computer game: This game is used to develop "selective attention" and "inhibitory control"

2. The social-emotional learning training package that includes five aspects:

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Self-awareness, self-management, social awareness, relationship skills, and responsible decision-making.

Table 1

Presentation of the Independent Variables (social-emotional Learning and Executive Functions) During 11 Sessions

	The intervention content of Emotional-social learning and the objective of each session	The intervention content of executive function and the objective of each session
Session 1	Intervention content: self-awareness training including identification of feelings and thoughts, and use of self-relaxation Objective: To properly evaluate the strengths and weaknesses, development of self-confidence and optimism	Intervention content: play with the Home software, Pack and Face software for 20 minutes. Objective: improving selective attention, sustained attention, shifting attention and inhibitory control
Session 2	Intervention content: self-awareness training including program notes and priorities, getting regular feedback from people. objective: just like the first session	Intervention content: just like the first session objective: just like the first session
Session 3	Intervention content: self-management training, including intrusive thoughts through labels, generalizations do not, and do not mind reading is not complicated stuff. Objective: stress management, impulse control and motivate their position to achieve personal and academic goals	Intervention content: just like the first session objective: just like the first session
Session 4	Intervention content: self-management training including handling anger through logical expression of anger, physical activity, adequate rest, use of relaxation stimuli ..... Objective: just like the third session	Intervention content: just like the first session objective: just like the first session

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Session 5	Intervention content: social awareness, including attention to emotional signs, giving appropriate and timely feedback to others. Objective: empathy, sensitivity to the interests and feelings of others and giving value to the interpersonal differences	Intervention content: just like the first session objective: just like the first session
Session 6	Intervention content: social awareness including understanding and learning the value of helping others, Understanding the value of cultural and ethnic backgrounds in communication with people. Objective: just like the fifth session	Intervention content: just like the first session objective: just like the first session
Session 7	Intervention content: social skills, including emotion control and creation of peaceful relations with others, convincing and reassuring others and development of the ability to actively listen. Objective: ability to form and maintain healthy and rewarding relationships with individuals and groups	Intervention content: just like the first session objective: just like the first session
Session 8	Intervention content: social skills including being honest in all circumstances, training Respectful criticism and timely expression of ideas Objective: just like the seventh session	Intervention content: just like the first session objective: just like the first session
Session 9	Intervention content: the ability to solve problems and make responsible decisions including education of problem defining and solution finding through brainstorming method Objective: development of the ability to create systematic and respectful opportunities associated with social interactions	Intervention content: just like the first session objective: just like the first session
Session 10	Intervention content: the problem-solving and responsible decision-making ability including decisions about choices and solutions such as, evaluation and revision of existing choices Objective: just like the ninth session	Intervention content: just like the first session objective: just like the first session

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Session 11	Intervention content: An overview of the five previous sessions Objective: To ensure the achievement of the objectives mentioned before	Intervention content: just like the first session objective: just like the first session

Results

Table 2 shows the mean, and standard deviation of mathematical functions (operations, content and applications) in both experimental and control groups and in both pre-test and post-test stages.

Shapiro - Wilk test showed that the distribution of scores obtained from different mathematical performance aspects was normal in the pre-test and post-test stages. Multivariate analysis of variance showed that the hypothesis (independence of pre-test variable) was established between the data of the present study (P >.05, F(df10,3)=1.547). Moreover, the Levin test showed that there is no significant difference between the variance of error in the pretest scores of mathematical performance in the experimental and control groups.

The hypothesis associated with the homogeneity of the regression line slope in the pre-test and post-test was not established. However, Tabachinick and Fidell (2013) believed that due to the equality of sample size in both groups, a deviation from the equality of regression line slope would not invalidate the analysis results.

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Table 2

Mean and Standard Deviation of Mathematical Performance in both Experimental and Control Groups, and in both Pre-Test and Post-Test Stages

Variables	Groups		Pre-test	Post-test
Concepts	Exp	M±S	17±6.35	29.14±5.64
		W	.907 (P> .05)	.966 (P> .05)
	contr	M±S	13.43±3.46	13.29±3.52
		W	.922 (P>.05)	.958 (P>.05)
Operation	Exp	M±S	14.71±7.56	23.29±13.38
		W	.910 (P> .05)	.826 (P> .05)
	contr	M±S	8.43±3.45	10.57±5.03
		W	.867 (P> .05)	.935 (P> .05)
Application	Exp	M±S	17.71±7.54	25.43±4.54
		W	.926 (P> .05)	.866 (P> .05)
	contr	M±S	11.86±3.93	11±2.77
		W	.888 (P> .05)	.923 (P> .05)
Math	Exp	M±S	49.43±29.58	77.86±21.13
function		W	.921 (P> .05)	.961 (P> .05)
(total	contr	M±S	33.71±7.69	34.86±6.2
score)		W	.833 (P> .05)	.831 (P> .05)

M: Mean S: standard deviation, W:Shapiro-wilk

Multivariate analysis of covariance (MANCOVA) was used to analyze the effect of the independent variable on the dependent variable levels. Evaluation of the hypothesis, referring to variance-covariance homogeneity according to "Box's M" statistic, showed that the observed covariance matrices of dependent variables were similar between the control and experimental groups (P =.256, F =1.295, Box's M=10.744). On the other hand, the results of Bartlett's sphericity test with a

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degree of freedom of 5, at a significance level of 0.01 is equal to 13.883. This revealed that there is an acceptable level of correlation between the levels of the dependent variable. Therefore, the analysis of multivariate covariance was a good technique to compare the effects of independent variables in the present study. In general, the results of the MANCOVA showed that linear combination of dependent variables (concepts, operation, and application) was significantly different in the experimental and control groups (Wilks lambda =0.300, partial=.215, P <.01, F (df7,3) =8.506).

This means that the application of the independent variable on at least one of the levels of the dependent variable makes a significant difference in the experimental and control groups. Therefore, ANCOVA was used to evaluate the effect of independent variable on each level of the dependent variable, separately. Table 3 shows the results of ANCOVA in comparison with different aspects of mathematical function in the experimental and control groups.

Table 3

ANCOVA in Comparison of Mathematical Function in both Experimental and Control Groups

Dependent variable	Inter-group mean square	Mean square of error	F	Sig	Partial^2 |
Concept	484.171	20.041	24.159	.001	.729
Operations	29.503	46.229	.638	.445	.066
Application	402.103	17.867	22.494	.001	.714

Note: degrees of freedom for group and error at all levels of dependent variable is equal to 1 and 9 respectively.

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According to the above table, the application of the independent variable (Combining training of executive functions and CASEL) affected the concept (P<.01, F ($df_{9, 1}$)= 24.159) and the application (P<.01, F($df_{9,1}$)=22.494) of mathematical performance. However, independent variable did not effect on math operations. It should be noted that Table 3 shows the Eta square (η^2) of each variable. Eta square means that a few percentages of the dependent variable variance is determined by the application of the independent variables. For example, the Eta square of concepts is equal to .729; this means that about 73% of the variance of students' performance in mathematics in component of concept is determined by the independent variable. Also 71.4% of the variance of application was explained by the independent variable. Bonferroni post hoc test was subsequently used to evaluate the direction of differences. The results showed that the adjusted mean of the experimental group in the component of concept (P<.01 and SE =2.895, $\Delta\bar{x}$ =14.231) and the application aspects of students' mathematical performance (P<.01 and SE =12.969, $\Delta\bar{x}$ =7.401), was significantly higher than the control group. Thus, according to the results of the analysis, it was concluded that the integration of executive function learning and CASEL could improve two components of math performance, concepts and application, in female students with mathematical disability.

Discussion

The results of this study suggested that the integrative of executive function learning and the Collaborative for Academic, Social and Emotional Learning (CASEL) could improve two aspects of concept and operation, of the mathematical performance in female students with mathematical learning

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disability. However, there is no significant effect on the operation.

This finding is consistent with the findings obtained from a large number of studies, such as: Best, Miller & Naglieri (2011), Langberg, Dvorsky & Evans (2013), Bull and Screif (2001), Clark, Pritchard & Woodward, (2010), Mirmahdi, Alizadeh, Saif Naraqi, (2009), and Holmes, Gathercole & Dunning (2009).

Children should have a set of pre-requisite skills such as attention, memory, concentration, problem solving abilities, etc. in order to master their assignments. It seems that difficulties in the executive functions lead to the reduction of concentration and development of attentional span in children. These skills are intrinsic processes that children use during problem-solving, learning, self-controlling and self-monitoring. Most children use these skills automatically; but children with learning disabilities usually encounter problems when using these skills, and thus, must be trained. Children need to possess these pre-requisite skills for mathematical achievement.

On the other hand, according to Fiske and Taylor (2008), a wide range of control levels; from full control level to lower control levels, can be noted in cognitive activities. It seems that mathematical functions, especially at the operation level, require processing at the control level. Other aspects such as concepts and applications could also be implemented at lower levels because they need to be prepared for reportable thoughts, and are implemented at the alert and conscious levels. Therefore, it is quite normal that the changes obtained in the mathematical function were mostly seen in the content and application aspects in the present study, and operations that require a higher level of processing, were not improved at all.

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The effectiveness of CASEL on students' academic performance was investigated in some studies. The results of Zins, Payton, Weisbereg & O'Brien (2007) and Narimani, Abbasi, Abolqasemi &Vahedi (2012), indicated an improvement in the academic performance of students which could be attributed to their attention to social-emotional issues. These results are consistent with those of the present study.

It can be argued that students experience a wide variety of emotions. A positive consequence of emotions facilitate learning, and negative consequences often hinder learning. In the same vein, the development of social-emotional skills and competencies plays an important role in the proper formation of behavioral patterns of interaction between people; raising awareness of one's moods and feelings; raising awareness of teacher and classmates' feelings and moods; management of emotions like anger; enhancement of problem-solving ability; timely and proper decision making, and contribution to maintenance of positive social relationships with peers.

Thus, the education of students on these abilities and skills can have positive effects on their academic performance in general and on their mathematical performance in particular. A mathematical function is normally of great importance among students; therefore, it seems to require higher levels of self-confidence and basic capabilities, compared to other courses. On the other hand, students with more powerful social capabilities, are usually provided with higher social support so that they can get help from their classmates and teachers when required. These capabilities will provide the ground for problem-solving associated with their mathematical performance, through the assistance and social support received from others.

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In the present study, the cognitive and emotional dimensions were investigated from the perspective of the Collaborative for Academic, Social and Emotional Learning (CASEL) and executive functions. This kind of investigation provided the present study with special aspects; since the integration of executive functions and CASEL could control and improve the cognitive and emotional dimensions. Attention to socio-emotional dimensions during learning helps to strengthen the learner's motivation and explains their active role in the learning process. Based on the socio-cognitive approach of Bandura, strengthening the motivation and active role of the learner in the learning process provides a basis for the perspective of the learner's agent (Bandura, 2018). Few researchers have integrated cognition and emotion in their study; for example, Latifi et al. (2009) study is consistent with the present study; and their research studies also focused on the emotional dimension. Although it appears that the improvement of emotional and cognitive dimensions can affect each other; the current research is consistent with Latifi et al. (2009).

According to cognitive-social theory of Bandura (1986), cognition and emotion interact with each other. Thus, we can say that in this study, the weakness in the executive functions was associated with a deficit in the emotional dimension on one hand, and poor social and emotional competencies will cause deficits in attention, problem-solving, memory and other executive capacities of the student on the other hand. Based on the broaden-and-build theory, positive emotions expand people's thought-action repertoires and allow them to build psychological, intellectual, and social resources. New evidence suggests that positive emotions may also play a role in motivating individuals

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to engage in positive behaviors leading to self-improvement (Armenta, Fritz & Lyubomirsky, 2017).

In the same vein, in the present study, students received training on the improvement of brain performance capabilities (including attention, in its different aspects, and concentration) and on emotional–social learning (Including self-awareness, self-management, social awareness, relationship skills and responsible decision making); thus, it seems that the effects on their mathematical performance, are much more efficient and sustainable. Based on the findings of this study, it was suggested that the integration of two methods; executive functions, and CASEL, could cause an improvement in the performance of students with learning disabilities. In addition, it was suggested that the effectiveness of these two methods are considered on reading and writing disorders by researchers.

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