

The Impact of Executive Functions-Based Intervention on School Engagement and Academic Self-Concept of Students with Dyslexia

Iranian Evolutionary and Educational
Psychology Journal
September 2019: 186-195
© University of Hormozgan Publication 2019
DOI: 10.29252/ieepj.1.3.186
<http://ieepj.hormozgan.ac.ir>

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Abstract: The present study aimed at investigating the impact of an executive function-based intervention on school engagement and academic self-concept of students with dyslexia. The research design was pretest-posttest with a control group. For this purpose, from the third-grade students of primary schools in Bandar Abbas in the academic year of 2011-2012, 30 boy students with dyslexia were selected according to the research criteria and randomly assigned to experimental (n=15) and control (n=15) groups. The data were collected by the School Engagement Questionnaire and School Self-Concept Inventory in pre- and post-test. The training package designed based on executive functions was taught to the experimental group during seven weekly sessions each lasted 90 minutes. The control group received no intervention. The results of the analysis revealed that the executive function-based intervention significantly influenced school engagement and academic self-concept of students with dyslexia. Considering the greater efficacy of the executive function-based intervention, it is suggested that this intervention be used to promote school engagement and self-concept in students with dyslexia.

Keywords: Dyslexia, Executive functions, School engagement, Academic self-concept

Introduction

According to the Diagnostic and Statistical Manual of Mental Disorders-V, specific learning disorder is a neuro-developmental disorder with a biological basis which results in abnormalities at the cognitive level. One of the main features of the specific learning disorder is the difficulties in academic skills including reading fluency, reading comprehension, written expression and mathematical reasoning (American Psychiatric Association, 2013a, 2013b).

Reading is one of the primary ways of acquiring knowledge. In many societies, reading and writing literacy are the key to academic achievement and students who are poor at reading demonstrate great vulnerability in learning different topics throughout and after school (Maughan et al., 2009). Nearly 80% of students with learning disabilities suffer from reading problems. Children with dyslexia might know many words and use them in speaking; however, they fail to understand and identify the written symbols. The major problems that these students experience include failure in reading similar words, guessing the words from the beginning and ending letters, reading words in reverse order, severe problems in spelling, unwillingness and disgust at learning and the difficulty in distinguishing whole from parts (Brooks, Berninger, & Abbott, 2011).

One of the problems of children with dyslexia is in executive functions (Seidman, 2006). Executive functions

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are important constructs that play an essential role in controlling and directing behavior and are imperative for adaptation and successful life performance. These functions allow individuals to start and complete tasks, cope with challenges, identify unexpected situations, quickly map out plans, manage daily stresses and discourage inappropriate behaviors (Anderson & Bushman, 2001; Smith & Jonides, 1999). The term executive functions refer to a general construct that includes various functions such as decision-making, planning, inhibition and organization and requires higher brain cognitive skills such as attention, working memory, language, perception and creative thinking. These functions help individuals accomplish their learning tasks, mental functions and academic activities (Best, Miller, & Jones, 2009; Tops, Callens, Van Cauwenberghe, Adriaens, & Brysbaert, 2013).

In general, executive function include attention to relevant information, focus on information and the inhibition of irrelevant information (attention and inhibition), shifting attention and focusing on tasks (task management), planning the sequence of performing tasks to attain objectives (planning), updating and reviewing the working memory content to determine the next steps in the chain tasks (reviewing) and representation of codes in working memory (encoding). Furthermore, these functions include integrating multifaceted sensory inputs, generating various responses, maintaining categories, goal-directed behaviors, adapting to environmental changes, planning capabilities and self-assessment (Harvey, Siu, & Romano, 2004).

Executive functions might play a key role in social development as well as school and academic achievement (Blair, 2016). Research has shown that any failure in the development of executive functions would interfere with planning for beginning, ending and remembering tasks, and as a result, might end in memory impairment and learning disorder (Brocki, Eninger, Thorell, & Bohlin, 2010). Furthermore, executive functions are related to students' academic performance (Rosselli, Matute, Pinto, & Ardila, 2006; Swanson & Jerman, 2007). Many studies have noted the poor performance of children with a neuropsychological learning disorder in executive functions/attention. These studies indicated that pre-school children with learning disabilities perform lower than normal children in executive function and attention tests (Meltzer, 2018; Swanson & Jerman, 2007). Studies conducted by Arizi, A. Abedi (2008), A Abedi, Pirooz Zijerdi, and Yarmohammadian (2012) and Mirmehdi, Alizadeh, and Seif Naraghi (2009), indicated that children with learning disabilities have difficulties in neuropsychological aspects, especially executive functions, and deficits in neuropsychological skills would, in turn, predict children's learning disabilities.

As stated by Dawson and Guare (2018), executive functions help to regulate the behavior in two ways. The first way requires the application of special mental functions for goal selection. These functions include:

Planning: The ability to create and generate a road map to achieve a goal or complete a task. Planning involves the ability to decide what is important and what is not.

Organization: The ability to design and maintain systems for maintaining information and content.

Time management: Estimating the duration, how long it takes, how much time should be allocated and how it should be considered. This skill involves the sense that time is important.

Working memory: The ability to keep information in mind while performing complex tasks. The ability to deliberate on learning or past experiences to be applied for future situations or projects.

Metacognition: The ability to reflect and see yourself in a situation. The ability to see how the problem is solved by the individual which includes self-monitoring and self-assessment (such as the questions of how do I do it? or how did I do it? and how can I do it better?).

These skills help create an overview of the goal, delineate a quick shortcut for that purpose and determine the sources that are required along the way. The second way is the functions that we need to achieve our goal and to guide our behaviors in the direction of achieving the goal. These functions include:

Response inhibition: Pre-operative thinking capacity. This is the ability to resist the temptation to say or do something and sometimes provides us with the opportunity to evaluate the situation and determine the way our behavior influences the situation.

Emotional control: (Sometimes called emotional self-regulation) is the ability to direct emotions and affects to achieve ultimate goals or to control and direct behavior.

Sustained attention: Enhancing the ability to attend to a situation or task despite the presence of distraction, fatigue or boredom.

Task initiation: The ability to initiate a task without procrastination and at the right time.

Flexibility: The ability to review designs when faced with barriers, errors and deficits. Flexibility involves adaptation to the new altered conditions.

Goal-directed persistence: The capacity or ability to pursue and achieve a goal and not to fall short of the major aim due to other demands or rival's interests (Dawson & Guare, 2018).

The impairment in the performance of these children suggests that these children experience difficulty paying attention to the important aspects of task, inhibition and control of irrelevant responses to the task and storing information obtained from the environment; furthermore, they cannot delay obtaining the reinforcement and they employ a task-oriented approach to the tasks and daily activities. These problems make it arduous for children to plan and respond to different tasks and integrate different parts of the tasks. As we all know, reading is among the daunting tasks and children require possessing an optimal level of the aforementioned abilities to perform properly. In sum, the ample evidence confirms the weaknesses in executive functions of students with learning disabilities, especially dyslexia (Wu, Anderson, & Castiello, 2002).

Another influential factor in academic achievement is school engagement which is critical to learning, to the extent that it is considered as an important precursor to learning (Zyngier, 2008). This variable is also considered as the core of most theories of academic failure (Finn, 1989). The school engagement constructs partly rooted in Social Control Theory (Hirschi, 2017), which emphasizes the role of individual feelings of attachment and belonging to social institutions. From this viewpoint, the antisocial behavior of youth is explained based on the links between the individual and the community, in the same way, anxiety can also be the result of weakening the relationship between the individual and the educational institutions. In Social Control Theory, these links are characterized by commitment, beliefs, attachment and engagement. In the new models of academic failure, these theoretical elements exerted a significant effect on the conceptualization of the student engagement construct. The general school engagement negatively predicted academic failure (Archambault, Janosz, Fallu, & Pagani, 2009).

Zulalie and Ghorbani (2014), indicated that the mean scores of dyslexia group in internal motivation variables, i.e., internal motivation for knowing, and general score of academic motivation, behavioral and cognitive engagement, and a general score of engagement for the school were significantly lower than the normal group.

It seems that a two-way relationship exists between academic achievement and self-concept. That is, on one hand, high self-concept and belief in one's abilities provide the motivation for learning, effort and academic achievement and on the other hand, academic achievement improves self-concept and self-esteem. Students, who value themselves more, achieve greater success in confronting others and are more resistant to difficulties, and if they consider themselves weak, they would soon give up any attempt (Marsh & Craven, 2006). Due to their poorer social and educational performance, children with dyslexia have a low academic self-perception, which in turn negatively influences their self-concept. Moreover, the process of labeling and awareness of their educational challenges negatively affect their self-concept (Vaughn, Elbaum, & Boardman, 2001).

Taylor, Hume, and Welsh (2010) compared normal children and children with dyslexia and reported significant differences in all self-concept strategies, academic, social, sport and rational status, physical appearance, fame, disappointment and satisfaction. Studies conducted on these children highlight the fact that due to successive failures in school tasks and reading, they have lower self-concept compared with their peers. Instead of trying, most children with dyslexia feel they are idiots. Taylor et al. (2010) stated that most often, children with dyslexia who are motivated to learn, want to show others that they are not idiot and in so doing, they suppress their desires and wishes.

Regarding the theoretical background and research results, since students with dyslexia suffer from deficits in school engagement, academic self-concept and executive functions, the present study aimed at designing and developing a student-centered training package based on executive functions and investigates its effects on school engagement and academic self-concept of students with dyslexia.

Material and Methods

The present study was a quasi-experimental study with pretest-posttest design with a control group. The statistical population of the study consisted of all students with dyslexia in third grade in Bandar Abbas educational and parish area that were referred to learning disorder clinics in 2018. About 30 male students with learning disabilities were diagnosed with learning disabilities were selected by convenience sampling and were randomly assigned into two groups (15 in the first experimental group and 15 in the control group). Entry criteria included third-grade elementary school education, diagnosis of dyslexia, entry satisfaction, and lack of participation in educational programs and satisfaction of intelligence status for participation in research. Exclusion criteria included dissatisfaction with the research, entering other educational and therapeutic programs other than the experimental intervention of present study and the absence of more than one session in educational intervention sessions. The mean age of participants was 9.58 years with a standard deviation of 0.98.

To develop and implement the intervention, firstly, using a qualitative method, the views of the experts about the executive functions was taken. Afterwards, the conceptual model of intervention was developed, using content analysis and coding method, and then, the training program was developed. In the end, at the quantitative part, after performing the pre-test in the control and experimental groups, the experimental group was trained using training package developed based on the conceptual model while the control group did not receive any training and finally, the post-test was administered to the experimental and control groups.

Tools

Researcher-made questionnaire for reading performance: This questionnaire was designed to evaluate students' reading performance based on the criteria presented for dyslexia in the Diagnostic and Statistical Manual of Psychiatric Disorders-V. This questionnaire includes 12 items that tap into 3 various aspects of reading skills, i.e., reading accuracy, reading fluency and reading comprehension. This questionnaire was administered to 300 students and its reliability was estimated using test-retest method and the results are presented in the table 1.

Table1. Reliability of reading performance using alpha and test-retest method

Variables	Cronbach's Alpha	Test-Retest Reliability
Reading Performance	0.87	0.81
Reading Accuracy	0.82	0.78**
Reading Fluency	0.84	0.76**
Reading Comprehension	0.94	0.82**

School Engagement Questionnaire: This questionnaire was developed by Wang, Willett, and Eccles (2011), and includes behavioral, affective and cognitive aspects of engagement. Behavioral engagement is composed of two subscales, namely attention and compliance which is measured by a five-point Likert scale. The effective engagement includes the two subscales of belonging and valuing and cognitive engagement consists of regulation and strategy subscales in a Likert scale. The factor analysis conducted by Wang et al. (2011), revealed that the factorial loads of all items on the six subscales were significant at .05, in a range of 0.50 to 0.89. The reliability coefficients of each subscale were equal to or higher than 0.70.

School Self-Concept Inventory: This inventory was developed by Chen and Thompson (2004), after administering to 1612 primary school students. This inventory includes 15 items which tap into various aspects of school self-concept (general, academic, non-academic) in elementary and middle school students. The scoring is done using a five-point Likert scale. The reliability of the inventory was estimated by Marashian and Khorami (2012), in a sample of 36 students in Iran and its Cronbach's alpha coefficient was 0.93. The framework for training sessions, based on executive functions and Barkley model, is summarized in Table 2.

Table2. Executive functions' intervention sessions

Session	Content	Time
1	Introducing members and stating the goals of the sessions, carrying out the initial evaluation and discussing the framework of the project	90 min.
2	Reading performance (specifying the purpose of the text, the proper study environment, focusing and attention during study, reviewing and re-examination of the text and compensating errors)	90 min.
3	Training mental imagery techniques and self-motivating	90 min.
4	Training regulation strategies and emotional self-regulation	90 min.
5	Addressing executive functions and academic performance	90 min.
6	Reviewing techniques	90 min.
7	Reviewing techniques	90 min.

Results

The mean and standard deviation of the school engagement variable and its subscales in the experimental and control groups at the pre- and post-test stages are presented in the table 3.

Table3. Mean and standard deviation of school engagement in the two groups

Variable	group	N	Pre-test		Post-test	
			M	SD	M	SD
School engagement	Experimental	15	65.60	4.80	75.13	5.63
	Control	15	66.52	4.55	67.30	6.55
Behavioral	Experimental	15	18.27	3.67	25.47	3.04
	Control	15	17.67	2.91	16.20	2.17
Affective	Experimental	15	20.27	2.14	21.47	2.47
	Control	15	22.50	2.13	22.70	2.58
Cognitive	Experimental	15	18.67	5.08	29.67	5.87
	Control	15	19.15	5.70	20.33	5.83

The mean and standard deviation of academic self-concept and its subscales in the experimental and control groups at the pre- and post-test stages are presented in the table 4.

Table4. Mean and standard deviation of self-concept and its subscales in the two groups

Variable	Group	N	Pre-test		Post-test	
			M	SD	M	SD
academic self-concept	Experimental	15	30.02	4.31	45.53	2.72
	Control	15	26	2.97	26.93	2.65
general	Experimental	15	10.67	1.98	15.07	1.62
	Control	15	9	1.7	9.53	1.45
academic	Experimental	15	15.53	2.53	24.47	1.8
	Control	15	13.33	2.46	13.47	2.32
Non-academic	Experimental	15	4	1.13	6	0.84
	Control	15	3.67	1.04	3.93	1.33

To examine the assumption of the normal distribution of scores and homogeneity of variance, the pre-test of school engagement and academic self-concept and their subscales were tested using Shapiro-Wilk and Kolmogorov-Smirnov tests respectively, whose results indicated the normality of the distribution and the homogeneity of variance.

Table5. Results of Shapiro-Wilk test for the normality of the distribution of pre-test scores of academic engagement and its subscales in the experimental and control groups

Variable	Group	Statistics	df	Sig.
academic engagement	Experimental	.95	15	.55
	Control	.93	15	.31
Behavioral	Experimental	.90	15	.12
	Control	.93	15	.28
Affective	Experimental	.96	15	.73
	Control	.94	15	.42
Cognitive	Experimental	.89	15	.07
	Control	.88	15	.06

As it is shown in Table 5, the normality assumption of pre-test scores of academic engagement and its subscales is confirmed.

Table6. Results of Shapiro-Wilk test for the normality of the distribution of pre-test scores of academic self-concept and its subscales in the experimental and control groups

Variable	Group	Statistics	df	Sig.
academic self-concept	Experimental	.90	15	.12
	Control	.92	15	.20
General	Experimental	.90	15	.06
	Control	.95	15	.60
Academic	Experimental	.96	15	.83
	Control	.92	15	.20
Non-academic	Experimental	.91	15	.17
	Control	.89	15	.09

As it is shown in Table 6, the normality assumption of pre-test scores of academic self-concept and its subscales is confirmed.

The first hypothesis of the present study was that executive function-based intervention significantly influences school engagement of students with dyslexia. To test this hypothesis and compare the two groups on school engagement, Wilks' Lambda test was used whose results are presented in Table 7.

Table7. Wilks' Lambda results for comparing the two groups in school engagement subscales

Source of Variance	Wilks Lambda	F	Assumed df	Error df	Sig.	Effect size	Statistical power
Behavioral	.94	.68	2	24	.56	.05	.18
Affective	.72	4.70	2	24	.00	.27	.86
Cognitive	1.15	1.15	2	24	.23	.08	.28
Group membership	.20	15.08	4	50	.001	.55	1

As it is shown in Table 7, there is a significant difference between the mean scores of the two groups in the three subscales of school engagement. In other words, the executive function-based training exerted a significant effect on the school engagement of the experimental group.

The second hypothesis of the present study was that executive function-based intervention significantly influences the academic self-concept of students with dyslexia. To test this hypothesis and compare the two groups on academic self-concept, Wilks' Lambda test was used whose results are presented in Table 8.

Table8. Wilks' Lambda results for comparing the two groups in academic self-concept subscales

Source of Variance	Wilks' Lambda	F	Assumed df	Error df	Sig.	Effect size	Statistical power
General	.92	1.07	2	24	.37	.08	.26
Academic	.86	1.90	2	24	.14	.13	.45
Non-academic	.89	1.47	2	24	.23	.10	.35
Group membership	.31	9.50	4	50	.001	.43	1

As it is shown in Table 8, there is a significant difference between the mean scores of the two groups in the three subscales of academic self-concept. In other words, the executive function-based training exerted a significant effect on the academic self-concept of the experimental group.

Discussion

Considering the fact that students with dyslexia are weaker than other students in school engagement and academic self-concept; therefore, greater attention has recently been paid to the motivational and affective aspects of these students. The present study aimed at investigating the impact of the executive function-based intervention on school engagement and academic self-concept of students with dyslexia. The present study revealed that training based on executive functions could have a significant effect on these variables and their subscales. In other words, it might be stated that through teaching the components of executive functions, the school engagement and academic self-concept of students with dyslexia will be improved.

The findings of the present study were consistent with Milton (2010), Dolgun, Savaşer, and Yazgan (2014), Lombardo (2013), GhamariGivi, Narimani, and Mahmoodi (2012), and Raisi and Javedan (2015). A review of the research suggests that approximately 75% of children with learning difficulties experience problems with affective and social skills. On the other hand, it might be stated that deficit and impairment in the use of affective and social processing are in some way consistent with deficits in executive functions (Clark, Prior, & Kinsella, 2002). This might be the case for the findings of the present study as well.

In discussing the first hypothesis, it can be stated that children who master executive functions' skills, acquire the qualifications for a successful presence at a community called the school. On the other hand, the findings suggest that frontal lobes, where the process of self-control of the brain and executive functions occur, are influential in the development of social-affective competence (Riggs, Jahromi, Razza, Dillworth-Bart, & Mueller, 2006).

Furthermore, school engagement and motivation are influenced by academic achievement. In fact, students avoid using impulsivity and aimlessness while exercising their executive functions and intelligently improve their academic performance through mastering meta-cognitive and working memory skills. This academic achievement might result in school engagement. Also, executive functions provide the requirements for completing a task, achieving a goal or qualification and competence. Students with high academic motivation are more engaged and motivated in school and attempt to achieve their academic goals.

To explain the second hypothesis of the present study which indicated the effectiveness of executive function-based intervention on academic self-concept of students with dyslexia, it might be stated that executive functions are the same brain functions that deal with voluntary and purposeful behaviors; they contribute to goal-oriented integration and management so that individuals can consider the short-term and long-term consequences simultaneously, evaluate their behavior immediately, as well as modify and optimize their behavior accordingly (Barkley, 2004). Therefore, it seems that a close relationship exists between academic self-concept and voluntary and purposeful behaviors resulting from executive functions (Adolph & Berger, 2011).

In the last few decades, the psychologists' view of the nature of self-concept has changed. Early scholars assumed the nature of self-concept as one-dimensional, unitary, and constant, while contemporary scholars believe that self-concept is a dynamic and multidimensional construct. As stated by Barkley (2004), executive functions enable organizing, focusing, sustained attention, changing from one stimulus to another, self-regulation and failure management in the student through the control and regulation of voluntary and purposeful behaviors.

The implementation of executive function-based intervention with the help of parents and providing appropriate strategies tailored to the internal capabilities accompanied by appropriate encouragement for learning improved students' self-concept scores. Deficits in executive functions in these students make them incapable of reviewing and controlling emotions and feelings in the preoperative stage and as a consequence, they develop a negative self-concept, compared with their normal peers. Training based on executive functions led to self-reflection, visualization and self-regulation of emotion and planning in the process of performing and organizing tasks to be able to complete them and as a result, they would be able to develop a positive self-image. A step-by-step training based on executive functions enables the student to provide a clear picture of a task

and by taking each step, he would feel empowered and would be motivated to take the next step. Asking for parents to help in monitoring the process of performing tasks and encouraging the child after completing each step increases the likelihood of success and further develops the child's self-concept. Inadequate self-regulation in students with dyslexia leads to weakness in emotional management to achieve goals, complete tasks, or control and direct disabling behavior. Therefore, training the effective coping strategies for students with dyslexia, in the form of a program based on executive functions, might improve emotional management and develop their academic self-concept.

It is worth noting that due to the nature of the relationship and interdependence between executive functions and academic self-concept, what contributed to the progress in academic self-concept and its subcomponents was the development of the executive functions skills that were acquired by training. To achieve the optimal performance, these executive functions should be converted to executive skills through continuous training to enable the transformation from external control to internal monitoring and control, and to generalize from a specific situation to other situations as well.

Further research, especially with the purpose of examining and evaluating the efficacy of executive function-based intervention in the daily life of this group of students, as well as other groups of learning disabilities might be the goal of the future applications of this program and finally, by seeking the assistance of experienced teachers in implementing such a program, self-confidence of students with dyslexia would be enhanced, and by providing an efficient management, school engagement and positive self-concept, the two influential variables in learning process, would be improved.

An important finding of this study was that children need to be equipped with a set of skills that include executive decision-making, planning, organizing, and inhibition to master school assignments. These skills, derived from experience, education and learning and stored in long-term memory, are internal processes that most children use to solve learning and control and supervision automatically, but children with learning disabilities have a neurological disability. Developments in the use of these skills are difficult to learn and need to be trained. The following suggestions are useful for early intervention in children with functional impairment: reducing environmental triggers, sitting in front of the class, specifying a specific time, and a specific time to do the task.

Children who have difficulty with executive functions such as planning and using strategies may also have difficulty organizing assignments, writing, drawing, or other complex activities; therefore, these children must be taught structures and rules in order to perform. Follow their assignments and activities.

Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The author(s) received no financial support for the research, authorship, and/or publication of this article.

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