Iranian Journal of Educational Sociology
(Interdisciplinary Journal of Education)
Available online at: http://www.iase-idje.ir/
Volume 4, Number 4, March 2022

Structural Relationships between Executive Function and Academic Engagement of Female Students: The Mediating Role of Perception of the Educational Environment

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Article history:
Received date: 2021/07/06
Review date: 2020/10/11
Accepted date: 2020/10/31

Keywords:
Academic engagement, Executive Function, Perception of Educational Environment, Female Students.

Abstract

Purpose: The objective of the present study was to investigate the structural relationships between executive function and academic engagement of female students: the mediating role of perception of the educational environment.

Methodology: This study was a cross-sectional correlational study. The statistical population of this study included ninth grade female students in Sari during the academic years 2018-2019. The sample size was 280 students who were selected by multi-stage cluster sampling method. Academic engagement (Zrang, 2012), executive function (Nejati, 2013) and perception of educational environment (Gentry et al., 2002) questionnaires were used for data collection. Data were analyzed by structural equation modeling using software SPSS-18 and Amos-23.

Findings: The results showed that the structural relationships between executive function and academic engagement of female students: the mediating role of perception of the educational environment had a good fit. In addition, executive function had a direct and significant effect on perception of educational environment and academic engagement. Perception of educational environment had a direct and significant effect on academic engagement and executive function with the mediating role of perception of the educational environment ($P < 0.05$).

Conclusion: According to the direct and indirect relationships of the present study, the academic engagement of female students can be improved by improving executive function with the mediating role of perception of the educational environment.

Please cite this article as: Rastegar F, Sadeghi J, Fallah V, Homayoni A. (2021), Structural Relationships between Executive Function and Academic Engagement of Female Students: The Mediating Role of Perception of the Educational Environment, **Iranian Journal of Educational Sociology.** 4(4): 86-.95.

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1. Introduction

One of the serious challenges in educational fields is the reduction in academic motivation, one of the important indicators of which is academic engagement of learners, and in recent decades this index has been considered as a strong predictor of learners' performance, progress and success (Metzger, Cooper, Griffin, Golden, Opara & Ritchwood, 2020). Academic engagement is one of the examples of academic investment for learning, understanding and mastering knowledge and information and learning academic skills (Van Ryzin & Roseth, 2021). This construct shows the individual's sense of belonging and tendency to participate in educational activities and even extracurricular activities. So that the activities attract the learners' attention, learners feel committed to doing them and try to complete them successfully (Datu, Yang, Valdez & Chu, 2018). Academic engagement enables learners to actively engage with the educational content provided in the educational environment to acquire the knowledge and skills needed to cross the various educational pathways (Sinclair, Gesel & Lemons, 2019).

This construct indicates the quality of effort and commitment that learners spend on purposeful educational activities to achieve the desired results (Buzzai, et al, 2021). Academic engagement is a multidimensional construct consisting of cognitive, motivational and behavioral dimensions. Cognitive dimension refers to cognitive and metacognitive strategies that show different processes of information processing used by learners during learning. Motivational dimension refers to emotional reactions, interest and validation of academic activities. Behavioral dimension refers to observable academic behaviors such as effort and perseverance when faced with academic difficulty while completing homework and asking teachers and classmates for help to understand and learn the curriculum (Ghadampour, Mirderikvand & Beiranvand, 2016). Learners with high academic engagement are more likely to engage in academic activities, exhibit more efforts, perseverance, and self-regulatory behaviors, enjoy challenging academic activities, and seek help from teachers and classmates appropriately when needed (Karki, Chaudury & Patangia, 2020).

One of the factors affecting academic conflict is executive function (White, et al, 2021) which has been the focus of neuroscientists and psychologists and plays an effective role in mastering homework, organizing, prioritizing, planning, coordinating and integrating information (Sibley, et al, 2019). Executive function plays a significant role in cognitive activities and planning for daily life and includes all complex cognitive processes and is responsible for regulating and reviewing cognitive processes (Oberer, Gashaj & Roebers, 2018). Executive functions are thought as a set of cognitive abilities that enable an individual to control and manage his or her thoughts and actions in the face of new or complex situations (Suntheimer & Wolf, 2020). This construct is considered as information processing in the absence of any emotional influence and means purposeful and future-based skills such as planning, flexibility, attention, inhibition, working memory and monitoring, which are assessed as non-contextual, analytical and non-emotional (Waters, et al, 2021).

Executive function is a general construct that includes a wide range of cognitive processes and behavioral abilities (Moffett & Morrison, 2020) and multidimensional construct consisting of dimensions of memory, selective inhibition and attention, decision making, planning, sustained attention, social cognition and cognitive flexibility (Nejati, 2013). Deficiencies in executive function can cause problems in the ability of an individual to initiate, plan, achieve objectives, monitor performance, predict results, flexibility in response, and appropriate behaviors (Aadland, et al, 2017). Learners with poor executive function succeed in short, structured, and standardized tests, but perform very poorly on tests that require an understanding of abstract concepts and reasoning (Korucu, Litkowski & Schmitt, 2020).

One of the mediating variables between executive function and academic engagement is the variable of perception of the educational environment, which means learners' perception of the educational environment, class and academic activities (Whittle, 2018). In another definition, perception of the educational environment refers to the physical, social, psychological, educational and cultural context in which learning takes place and learners' perception of it affects the learner, learning conditions and growth

and development of learning (Riveros-Perez, et al, 2016). The educational environment is a social system that includes learners and those with whom they interact. In other words, the educational environment is a situation in which learners and teachers interact with each other and use a variety of information resources for learning activities (Havik & Westergard, 2020). Perception of the educational environment is a motivational and multidimensional construct consisting of dimensions of joy, choice, challenge and interest. The dimension joy refers to the degree of satisfaction and pleasure of learners towards the educational environment in which they are placed. The dimension choice refers to the extent to which teachers allow learners to participate in decision-making. The dimension challenge then refers to the desire of learners to face academic challenges and strive to overcome them. The dimension interest refers to the degree of interest, willingness, and belonging of learners to the learning environment (Gentry, Gable & Rizza, 2002).

Learners' perception of educational environments is an important and unique index for measuring the quality of classroom and learning, and its positive structural (teacher, content, education, etc.) and process (learners interact with each other, learners and teachers interact, etc.) perception plays an important role in appropriate and optimum learning (Knowles, 2020). In learning environments or classrooms that use a variety of assignments, mastery evaluation, and encouragement of autonomy that are guiding and entertaining, learners' sense of academic effectiveness and self-esteem increase, and they achieve better academic performance and greater academic success (Stack, et al, 2019).

Few studies have been conducted on relationships between executive function, perception of the educational environment, and academic engagement. For example, the study results of Veraksa, Bukhalenkova and Almazova (2020) showed a positive and significant relationship between executive function and the quality of classroom interactions. Piccolo, Merz and Noble (2019) in a study concluded that executive function had a positive and significant relationship with perception of class atmosphere. Also, the study results of White et al. (2021) showed that executive function and engagement had a positive and significant relationship. In another study, Brock, et al (2009) reported that executive function had a positive and significant relationship with academic achievement, school-related behaviors, and academic engagement of children. In addition, the study results of Havik and Westergard (2020) showed a positive and significant relationship between perception of classroom interactions and academic engagement. Aryaeepanah and Sadoughi (2020) in a study concluded that perception of the classroom environment was positively and significantly related to students' academic engagement and could predict it significantly. The study results of Moltafet, Taghvainia and Ayool (2020) showed that class perception had a direct and significant effect on academic engagement. In another study, Lerdpornkulrat, Koul and Poondej (2016) reported that perception of the classroom environment; objective structure, motivation, and academic engagement were positively and significantly related.

For the importance and necessity of the present study, it can be said that adolescent female students, in addition to playing an effective role in the growth and development of society in the near future, will be responsible for training the next generation. Undoubtedly, one of the effective motivational variables in these fields is academic engagement, which can to a large extent guarantee academic and professional success and even success in personal and family life. Another important point is that previous studies have investigated the factors related to academic engagement from different aspects and its relationship with many variables has been measured. But according to the existing gaps, we can investigate the relationship between executive function, perception of educational environment and academic engagement. In addition, no study was found that has measured the effect of executive function on the perception of the educational environment. Therefore, it is necessary to assess the effect of these variables on academic engagement to provide solutions to improve academic engagement if they are effective. As a result, the present study was conducted aimed to investigate the structural relationships between executive function and academic engagement in female students: the mediating role of perception of the educational environment.

2. Methodology

This was a cross-sectional correlational study. The statistical population of the study included ninth grade female students in Sari during the academic year 2018-2019. In structural equations, the sample size should be at least 10 times the number of variables and at most 20 times the number of variables (Homman, 2004). Since in the present study there are 14 variables (7 variables of executive function, 3 variables of academic engagement and 4 variables of perception of educational environment), the sample size was calculated 20 times the number of variables, i.e. n = 280, selected by multi-stage cluster sampling method. In this sampling method, first Sari is divided into four districts, two districts are randomly selected and then from each 5 classes and a total of 10 classes are selected randomly from each district. On average, n = 28 were randomly selected from each district and if there are inclusion conditions they were selected for the study as a sample. Inclusion criteria included willingness to participate in this study, no use of psychiatric drugs, living with parents and no stressful events such as divorce and death of loved ones in the past three months and exclusion criteria included refusing to complete questionnaires and not responding to more than 10% of the items.

Academic Engagement Questionnaire

Academic Engagement Questionnaire was designed by Zrang (2012) with 38 items and 3 cognitive (19 items), motivational (10 items) and behavioral (9 items) dimensions. The items are scored based on a five-point Likert scale (1 = always incorrect to 5 = always correct) and total score range of the tool is between 38 and 190, and a higher score indicates more academic engagement. Zrang (2012) confirmed the construct validity of the tool by factor analysis and the reliability by Cronbach's alpha for the tool was 0.90, 0.83 for cognitive dimension, 0.73 for motivational dimension and 0.80 for behavioral dimension. In another study, Ghadampour et al. (2017) reported reliability using the Cronbach's alpha for the whole tool of 0.91, 0.84 for cognitive dimension, 0.78 for motivational dimension and 0.77 for behavioral dimension. In the present study, the value of reliability was calculated by Cronbach's alpha for the whole tool 0.87, 0.82 for cognitive dimension, 0.82 for motivational dimension and 0.79 for behavioral dimension.

Executive Function Questionnaire

Executive Function Questionnaire was designed by Nejati (2013) with 30 items and 7 dimensions of memory (6 items), inhibition control and selective attention (6 items), decision-making (5 items), planning (3 items), sustained attention (3 items)), social cognition (3 items) and cognitive flexibility (4 items). The items are scored based on a five-point Likert scale (1 = almost never to 5 = almost always) and the total score range of the tool is between 30 and 150, and a higher score indicates more desired executive function. Nejati (2013) confirmed construct validity of the tool by factor analysis and reliability by Cronbach's alpha for the tool 0.83, 0.75 for memory, 0.62 for inhibition control and selective attention, 0.61 for decision-making, 0.57 for planning, 0.54 for sustained attention, 0.43 for social cognition and 0.45 for cognitive flexibility. In another study, Ashori (2019) reported reliability by Cronbach's alpha for the tool to be 0.83. In the present study, the reliability by Cronbach's alpha for the tool was 0.89, 0.85 for memory, 0.77 for inhibition control and selective attention, 0.80 for decision-making, 0.86 for planning, and 0.86 for sustained attention, 0.84 for social cognition and 0.83 for cognitive flexibility.

Perception of Educational Environment Questionnaire

Perception of Educational Environment Questionnaire was designed by Gentry et al. (2002) with 31 items and 4 dimensions of interest (8 items), challenge (9 items), choice (7 items) and joy (7 items). The items are scored based on a five-point Likert scale (1 = never to 5 = always) and the total score range of the tool is between 31 and 155, and a higher score indicates a more desirable perception of the educational environment. Gentry et al. (2002) confirmed construct validity of the tool by factor analysis and the reliability by Cronbach's alpha for the tool was 0.92, 0.84 for interest, 0.70 for challenge, 0.69 for choice and 0.91 for joy. In another study, Mohamadpor (2016) reported reliability using the

Cronbach's alpha for the tool to be 0.90, 0.78 for interest, 0.74 for challenge, 0.80 for choice, and 0.91 for joy. In the present study, the value of reliability was calculated by Cronbach's alpha for the tool to be 0.85, 0.84 for interest, 0.77 for challenge, 0.84 for choice and 0.70 for joy.

In order to conduct this study, after coordinating with the officials of Sari Education Department and expressing the importance and necessity of this study for them, research permission was obtained and after preparing the list of schools and the number of their classes, first a number of schools and then a number of ninth grade classes were randomly selected from each school. The importance and necessity of this study was stated and they were reassured about the observance of ethical considerations. At the researcher's next visit to the schools, the tools, which included academic engagement, executive function, and perceptions of the learning environment questionnaires, were completed by the students.

In the present study, the data were analyzed by academic engagement, executive function and perception of the educational environment questionnaires by structural equation modeling using software SPSS-18 and Amos-23.

3. Findings

In this study, the data were first screened and in addition, there was no sample drop and the participation rate in the study was 100%. The results of mean, standard deviation, minimum and maximum of research variables were reported in Table 1.

Table1. Results of mean, standard deviation, minimum and maximum of research variables

variables	M	SD	min	max
cognitive	32/19	4/52	19	45
motivational	28/75	5/08	15	40
behavioral	29/11	4/96	20	35
academic engagement	90/05	12/43	53	121
memory	15/75	2/75	8	29
inhibition control and selective attention	13/03	1/13	7	25
decision-making	13/85	2/85	6	21
planning	6/49	1/20	5	15
sustained attention	8/20	1/86	4	14
social cognition	7/87	2/59	4	12
cognitive flexibility	7/21	2/44	4	17
executive function	72/37	8/00	38	131
interest	20/44	3/10	14	35
challenge	19/78	4/19	11	38
choice	20/04	5/75	8	33
joy	21/36	6/03	8	35
perception of the educational environment	81/62	18/75	33	138

The results of mean, standard deviation and minimum and maximum of the research variables including academic engagement, executive function and perception of the educational environment and the dimensions of all three variables are shown in Table 1. The results of correlation coefficients of executive function, perception of educational environment and academic engagement were reported in Table 2.

Table2. Results of correlation coefficients of executive function, perception of educational environment and academic engagement

variables	executive function	perception of educational environment	academic engagement
executive function	1		
perception of educational environment	0/16**	1	
academic engagement	0/34**	0/38**	1

A positive and significant relationship was between the variables of executive function, perception of the educational environment and academic engagement at the significance level less than 0.01 (Table 2). Structural equation modeling assumptions showed that in addition to the correlation between variables, the assumption of normality for all variables based on Kolmogorov-Smirnov test due to the significance level greater than 0.05 and skewness and kurtosis due to the range +2 to -2. The study results of structural relationships between executive function and academic engagement of female students: the mediating role of perception of the educational environment with standard coefficients is reported in Figure 1.

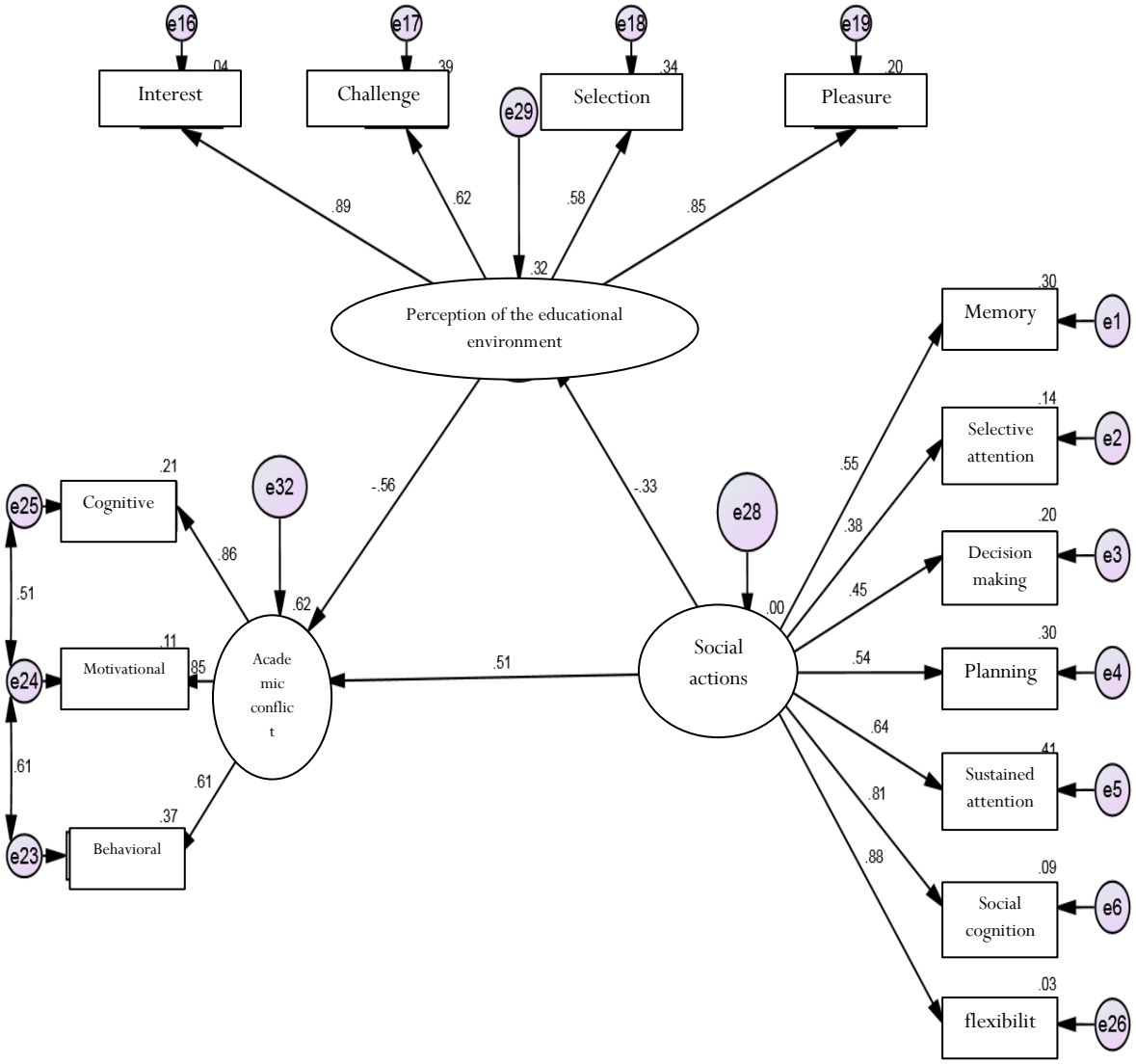

Figure1. Structural relationships between executive actions and academic engagement of female students: the mediating role of perception of the educational environment with standard coefficients

The results of the indicators of fitting the structural relationships between executive actions and academic engagement of female students: the mediating role of perception of the educational environment was reported in Table 3.

Table3. Results of the indicators of fitting the structural relationships between executive function and academic engagement of female students: the mediating role of perception of the educational environment

indicators	χ^2/df	RMSEA	GFI	AGFI	NFI	CFI
Calculated value	2/85	0/04	0/99	0/99	0/96	0/96
Accepted limit	≤3	≤0/08	≥0/90	≥0/90	≥0/90	≥0/90

The structural relationships between executive function and academic engagement of female students: the mediating role of perception of the educational environment based on the reported indicators of fitting indicating a good fit of the model (Table 3). The results of direct and indirect effects of the academic engagement model based on executive function: the mediating role of perception of the educational environment is reported in Table 4.

Table4. Results of direct and indirect effects of structural relationships between executive function and academic engagement of female students: the mediating role of perception of the educational environment

path	effect	standard coefficient	t	significance
direct	executive function on perception of the educational environment	0/33	3/24	<0/001
	executive function on academic engagement	0/51	6/55	<0/001
	perception of the educational environment on academic engagement	0/56	5/01	<0/001
indirect	executive function: the mediating role of perception of educational environment on academic engagement	0/18	5/73	<0/001

Executive function had a direct and significant effect on perception of educational environment and academic engagement; and perception of educational environment had a direct and significant effect on academic engagement at the significance level less than 0.001. Executive function: the mediating role of perception of educational environment had an indirect and significant effect on academic engagement at the significance level less than 0.001 (Table 4).

4. Discussion

Academic engagement plays an important role in academic performance and achievement. Although many studies have been conducted in this field, few studies have investigated the effect of executive function and perceptions of the educational environment. As a result, the present study was conducted aimed to investigate the structural relationships between executive function and academic engagement of female students: the mediating role of perception of the educational environment.

The study results showed that executive function had a direct and significant effect on the perception of the educational environment and academic engagement. These results on the effect of executive function on the perception of the educational environment are consistent with the study results of Veraksa et al. (2020) and Piccolo et al. (2019); and the study results of White et al. (2021) and Brock et al. (2009) on the effect of executive function on academic engagement. Explaining these results based on a study by Nejati (2014), the dimensions of executive function including memory, inhibition control and selective attention, decision-making, planning, sustained attention, social cognition and cognitive flexibility should be mentioned. Learners with higher memory for a variety of subjects often have better academic performance, and higher capacity for working memory results in higher efficiency in comprehension, recall of information and less error. Learners with higher working memory capacity use more appropriate learning strategies while having better academic performance. Inhibition control and selective attention are essential as two complementary cognitive functions for study and learning. In the absence of inhibition control and selective attention, the learner cannot pay selective attention to the curriculum, and distractions prevent information from entering the individual's processing system. Accordingly, the two cognitive functions are important factors and prerequisites for successful academic performance. Appropriate decision-making engages the learner more in learning the content. In other words, the learner envisions a more active role in learning for himself / herself and achieves it with effort and perseverance. Planning helps learners to set appropriate learning objectives for themselves and not just pursue lesson-based objectives. When learners define their own assignment, they are more motivated to do it and feel more efficient, leading to better educational outcomes. Sustained attention is a process, in which a person has to maintain cognitive resources on information for a long period of time, and those with sustained attention deficit cannot focus on their assignment for a long time and their attention is quickly shifted from one subject to another. Social cognition is distinct from executive function in terms of brain infrastructure. Executive function is based on logic and called cold cognition, but social cognition is based on emotion and is

called hot cognition. If we consider cognitive abilities to process and manipulate information, working memory is exactly consistent with this, and accordingly working memory is considered the core of cognitive functions, which some call general intelligence or antisocial intelligence, which is the exact opposite of social cognition. Cognitive flexibility is the ability to think without resistance and to shift attention from one subject to another. For learning the content, one should be able to shift one's attention from one subject to another in a timely manner and engage in another subject. The ability to adapt to unfamiliar and unexpected situations is needed to creatively combine concepts and integrate different representations. Given the explanations related to the dimensions of executive function and their role in education and learning, it can be expected that this variable has a direct and significant effect on the perception of the educational environment and academic engagement.

Also, the study results showed that perception of the educational environment had a direct and significant effect on academic engagement, which is consistent with the study results of Havik and Westergard (2020), Aryaeepanah and Sadoughi (2020), Moltafet, et a. (2016). Explaining the results according to the study results of Moltafet, et al (2020), it should be stated that an appropriate and desired perception of the educational environment is formed when there is assignments, research, and teacher participation and support along with cooperation and justice. Therefore, teachers should provide assignment- and research-oriented atmosphere in the classroom, along with support, cooperation, and justice. When teachers motivate students to learn and research and provide them with opportunities, they are in fact encouraging students to engage and play an active role in learning. Thus, the perception of the learning environment as a justice-oriented, participatory, and belonging class creates a positive feeling in them by responding to students' interests, and such a class gives them the opportunity to select and enjoy learning activities such as listening to ideas of others, accept criticism and provide feedback, and pave the way for student participation and engagement in education and learning activities.

In addition, the study results showed that executive function with the mediating role of perception of the educational environment had an indirect and significant effect on academic engagement. No study has been found in this field, but interpreting these results, it should be stated that the effect of executive function on academic engagement is due to the mediating role of cognitive variables, including self-efficacy, self-esteem, cognitive and metacognitive learning strategies, etc. and motivational variables, including internal motivation, positive attitude, vitality, positive beliefs, etc. Since the perception of the educational environment has both cognitive and motivational dimensions, so we can expect that the perception of the educational environment is a good mediator between executive function and academic engagement. As a result, the variable of executive function through perception of the educational environment can have an indirect and significant effect on academic engagement.

Each study faces limitations during the implementation and the limitations of the present study were cross-sectional method and the single-gender sample. Therefore, it is recommended to conduct studies on students of other grades and even other cities and repeat this study on male students and compare their results with the results of the present study. Another limitation of this study was the lack of attention to variables such as economic status and social and cultural level of families, which is suggested to be considered in future studies or even assss and compare the relationships between variables according to different economic, social and cultural situations.

Given the direct and indirect relationships given in the present study, to increase the academic engagement of students, programs can be designed and implemented to improve executive function and perception of the educational environment. For this purpose, computer games or rehabilitation programs can be used to improve executive function, and the educational environment can be transformed into positive environments through appropriate content, experienced teachers, and appropriate and active teaching methods, improving students' perception. Undoubtedly, by improving executive function and perception of the educational environment through the above processes, an effective step can be taken to increase the academic engagement.

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