Original Article

Predicting Academic Performance Based on Brain Executive Functions with the Mediation of Creativity among High School Students

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Abstract

The purpose of the study was to predict the academic performance based on executive functions of the brain with the mediating role of creativity. The success that each student can achieve in education is of the most significant concerns of the education system. Creativity is one of the factors that are closely related to learning. Nurturing creativity is of the most significant goals of education. Moreover, executive functions are of the significant components of students' academic performance. Over the last decade, there has been increasing attention to the role of executive functions in childhood, with the development and proper training of executive functions playing a key role in the social development, academic and educational success of children. The research method was multivariate descriptive of the correlational type conducted in the survey method. Spss 24 was used for data analysis. Descriptive data were mean, standard deviation, standard error, frequency table and correlation coefficient with multivariate regression used for statistical analysis. The results showed that the direct coefficients between the executive function to creativity were insignificant, but the coefficient of this construct to academic performance was significant at the 0.01 level, with no significant coefficients found between creativity and academic performance. Finally, creativity did not mediate the relationship between executive function and academic performance and there was only a direct effect between these two variables.

Keywords: Academic performance, creativity, executive functions of the brain

INTRODUCTION

In today's world, education is one of the most significant necessities of life so that life is endangered without education. As education needs high expenses and budget, the purpose of academic education is to enhance students' academic performance. Governments allocate a great share of national income to education and the families incur a lot of money to educate their children. The increase in academic performance means academic success. Academic success is how successful the learners have been in reaching the goals of the course [1].

Academic performance is a multidimensional issue and depends on the social, political, cultural, cognitive and emotional development of individuals to some extent in the community. Although many scholars have emphasized the effect of mental and cognitive abilities on it [2], recent studies have shown brain executive functions[2] (Payo, 2014, quoted from Mohammadi et al., 2014) as influential variables associated with academic performance.

The education system in most countries from first grade to university only focuses on using the mind to store information instead of nurturing the amazing power of the student's mind to create new ideas and turning them into reality. As one of the essential cognitive and human traits in humans (Dacosta et al. 2005; Henrique, 2011, quoted from Jokar and Alborzi, 2011) [3], creativity is potentially inherited and every individual potentially possesses creativity more or less (Ranco, 2004; Crapley, 2001 quoted from Jokar and Alborzi, 2011) [3]. However, the absence of a

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suitable environment and neglect of this ability prevent it from emerging (Loferransova, 1986: p. 196). For this purpose, creativity has a special status in educational psychology today and identifying and educating creative children are of the most significant educational programs in the countries [4].

It has to be noted that CNU World Study considers creativity as the most significant asset in the world today, and Stargow (2010) argues that creativity is responsible to make life meaningful and enjoyable, as well as processes like target setting, planning, prioritizing, organizing, flexibility, retention, and manipulation of information in working memory and self-monitoring influence students' success (Mills 2010, quoted from Mir Mhadi, 2007) [5]. However, the relationship between creativity and executive functions is not so clear. In other words, creativity as one of the prominent human features and its relation to various variables have been shown in various studies, but less evident in brain executive functions and also in a relationship with each other for academic performance and the effect they have on each other. Most studies have emphasized only the role of one function such as working memory. However, not many studies have been conducted on other issues [5]. The study was considered as first, it provides useful research information for students' awareness of the role of executive functions and creativity in performing tasks. Second, it enables teachers and educational professionals to find and propose practical and effective solutions to increase the capacity and efficiency of the creativity and performance components of the students' brain functions.

Concerning this, the study was designed and conducted to predict academic performance based on executive functions of the brain with the mediating role of creativity in high school students.

In examining the relationship between executive functions (inhibition, updating and flexibility) and positive and negative moods with students' creativity, Fakhravari et al. (2016) concluded that positive mood to negative mood facilitates creative performance[6]. Positive mood enhances creative thinking by working memory and high-low processing along with inhibition only plays a role in the creation or production of ideas. Based on this study, one can deduce that creative thinking is not just a spontaneous or emotional process of thought, and depends on controlled up-down activities.

Regarding this, in a study entitled "The relationship between executive functions and working memory capacity with students' reading performance," Valipour (2016)[7] found a positive relationship between executive functions (working memory, inhibition, mental planning, and attention) and reading and that intelligence and gender did not moderate the relationship between executive functions and reading performance. However, age had a moderating role in executive functioning and reading performance. The results were consistent with Miyake's theory that executive functions are separated but interconnected, and that individual differences in students' performance should be considered as their academic performance is highly influential.

In a study entitled "The relationship between physiological learning styles and creativity with academic performance of the students of Birjand University of Medical Sciences in the academic year 2014-2015," Mohammadi (2014) found a significant relationship between learning styles (visual and auditory) and creativity and academic performance among the students but there was no significant relationship between learning style (kinetic) and academic performance. The mean scores of creativity and learning styles in students were not significantly different in terms of gender and department.

In a study entitled "Examining the relationship between learning styles and creativity with academic performance concluded," Hosseini Nasab and Sharifi (2010) found no relationship between creativity and academic performance and the three components - abstract conceptualization, reflective observation, and development - have a relationship with students' academic performance[8].

Hosseini (2007) studied the role of teacher creativity in students' creativity, academic performance, and self-concept, and concluded that teachers' creativity training program could be a suitable model for nurturing creativity and the students' academic performance[9]. Moreover, studies by Felice and Renzoli (2002) and the report by Marjison (2004) have shown that creativity training has a significant effect on students' creative abilities and has little effect on elementary students' self-concept.

Malekpour et al. (2015) studied the effectiveness of working memory training in executive functions and the academic performance of students with spelling deficits[10]. The results indicated that after the end of the training period, reasoning in the executive functions and executive performance of the brain could play a significant role in predicting creativity. This could be an implication for training these skills to students and how they relate to these variables. Moreover, Gilholi et al. (2007) concluded that those with higher executive capabilities produce innovative and new ideas, whereas no significant interaction was found between working memory and latent creative problem-solving.

Mennati (2011) studied the role of executive functions in first-grade students' academic success concluding that reading and writing skills at the end of the first grade are related to executive functions of the brain and only working memory has significantly contributed to the inconsistencies in academic success[11].

Methodology

The study was descriptive (correlational) conducted to predict academic performance according to executive functions in high school students through a survey. The population of the study was 120 female high school students in Rafsanjan selected based on a convenient sampling method.

Data collection was done using a questionnaire. In doing so, Psychometric Properties of Behavioral Rating Scale of Executive Functions (BRIEF) was used to assess and evaluate the components of brain executive functions, designed in two forms of parent and teacher used for children and adolescents aged 5-18 years. The teacher form was used in the present study. BRIEF has 86 items answered as never, sometimes and often: never 1, sometimes 2, and often 3. Eight major executive functions were measured by the questionnaire. They are inhibition, shift, emotional control, initiation, working memory, planning, organization, and monitor. The questionnaire was scored based on a Likert scale.

The selection of questions and including them in the BRIEF grading form was based on reliability correlations between referees and question-scale correlations, with the highest likelihood of informing psychotherapists. The form of executive function grading has good reliability, with the highest test-retest reliability (0.88 for teachers and 0.82 for parents) and the internal consistency coefficient (Cronbach's alpha 0.88 for teachers). The correlation between teachers and parents is from 0.32 to 0.34. Evidence for convergent and divergent validity of this scale was derived from the correlation of this scale with other measures of behavioral and emotional functioning. Moreover, it has been found that the BRIEF grading form has proven successful in differentiating children and adolescents with attention-deficit / hyperactivity disorder (ADHD) (Sullivan and Jeremy, 2007, quoted from Abedi, 2010) [12].

Moreover, the Torrance Tests of Creative Thinking (Figural Form B) was used to evaluate the level of creative thinking of the subjects. This form has three activities, and the subjects create their own taste within 10 minutes for each activity, all of which need 30 minutes for each subject. Torrance (1974) shows the reliability between 0.75 and 0.78. The reliability of this test was shown to be 0.80 (reliability coefficient) by Pirkhaefi (1994) for the whole test in Iran.

Academic performance was evaluated by a teacher-made test of the core subjects at the end of the academic year. The researcher designed the test from three main lessons and presented it to several educational experts to determine validity, all of whom stated that the test questions addressed all of the main themes of the courses and this comprehensive test was taken from the subjects in a 2-hour session and the test was corrected by the relevant experts themselves and the scores were given to the researcher.

Data analysis was done by SPSS 24. Descriptive data were mean, standard deviation, standard error, frequency table and correlation coefficient with multivariate regression used for statistical analysis.

Results

1. Descriptive analysis of the data

The size of the final sample was 120 subjects after screening data and excluding incomplete and incomprehensible questionnaires.

Table 1: Frequency of the samples in terms of education

Grade	Frequency	Percentage	Valid percentage	Cumulative percentage
Seventh	56	46.7	47.1	47.1
Eighth	56	46.7	47.1	94.1
Ninth	7	5.8	5.9	100.0
All	119	99.2	100.0	
Missing data	1	0.8		
Total	120	100.0		

According to Table (1), most research samples are from seventh and eighth grades.

Table 2: Frequency of the samples in terms of age

Age	Frequency	Percentage	Valid percentage	Cumulative percentage
Twelve	9	7.5	7.8	7.8
Thirteen	34	28.3	29.3	37.1
Fourteen	51	42.5	44.0	81.0
Fifteen	22	18.3	19.0	100.0
All	116	96.7	100.0	
Missing data	4	3.3		
Total	120	100.0		

According to Table 2 data, about 42% are 14 years old and 7.5% are 12 years old.

The dependent variable was students' academic performance, measured using their academic average or grade point average (GPA).

Table 3: Descriptive Variables of Students' GPA (n = 120)

Variable	Mean	SD	Skewness	Kurtosis	Min.	Max.

GPA	17.67	1.63	-0.961	0.283	13	20

According to the data in the table above, the GPA of all students was 17.67 with a standard deviation of 1.63. The minimum GPA was 13 and the maximum was 20. Based on skewness and Kurtosis indices, the distribution of this variable is normal. According to statisticians, if the skewness and Kurtosis indices are in the range of -1 to +1, it shows the normal distribution of the scores (Meyers, Gamst & Guarino, 2006[13]; translated by Sharifi et al., 2012, p. 85).

The intermediate or second dependent variable (student creativity) has four sub-components: fluidity, flexibility, innovation, and expansion.

Table 4: Descriptive indices of creativity (n = 120)

Variable	Mean	SD	Skewness	Kurtosis	Min.	Max.
Fluidity	18.7034	5.34343	0.126	-0.470	5.00	28.00
Flexibility	13.2119	4.51938	0.437	0.127	3.00	25.00
Innovation	6.4661	2.37394	0.084	-0.179	0.00	12.00
Expansion	8.8814	4.78632	0.368	-0.532	1.00	20.00
Total score	47.2627	12.52719	-0.064	-0.046	11.00	79.00

The mean student creativity is 47.26 with a standard deviation of 12.52 (Table 4). Skewness and Kurtosis are in the range of -1 to +1, which shows that the distribution of variables is normal. According to the statistics, if the Skewness and Kurtosis indices are within this limit, it shows that the distribution of scores is normal (Meyers, Gamst & Guarino, 2006[13]; translated by Sharifi et al., 2012, p. 85).

The executive function construct in the present study has eight components - inhibition, attention shift, emotional control, initiation, working memory, planning, material organization, and monitoring, divided into two main components of behavioral and metacognitive regulation (Table 5).

Table 5: Descriptive indices of the types of components of executive function (n = 120)

Variable		Item	Mean	SD	Skewness	Kurtosis	Min.	Max.
Behavioral regulation	Inhibition	16	27.8932	4.48071	0.959	1.733	18.00	42.00
	Attention shift	12	21.9238	2.71284	-0.056	2.278	14.00	32.00
	Emotional control	9	14.3271	2.59817	0.458	0.184	9.00	22.00
Metacognition	Initiation	7	12.9083	2.15399	-0.247	0.334	7.00	19.00
	Working memory	11	18.2075	2.75583	0.241	0.193	12.00	27.00
	Planning	14	24.0467	4.01738	0.409	0.730	16.00	36.00
	Material organization	6	7.9273	1.73316	0.749	-0.176	6.00	13.00
	Monitoring	11	19.1376	2.87540	0.733	1.270	13.00	28.00
Mean behavioral regulation		37	63.7959	7.86347	1.109	2.292	47.00	91.00
Mean metacognition		49	81.8942	11.00831	0.458	0.628	62.00	116.00

According to the data in Table 4, the mean behavioral regulation is 63.79 with a standard deviation of 7.86. The metacognitive component had a mean of 81.89 with a standard deviation of 11. Skewness and Kurtosis indices of these two principal components were not in the +1 and -1 domain that showed that the distribution of scores for these variables was normal. Such a state is commonly seen in some positive variables and can be obtained by statistical transformations or deletion of outliers by a normal distribution.

Table 6: Pearson correlation coefficients matrix among the main variables of the study (n = 120)

Variables	(1)	(2)	(3)	(4)	(5)	(6)
Fluidity (1)	1					
Flexibility (2)	** 0.725	1				
Initiative (3)	** 0.368	** 0.405	1			
Expansion (4)	* 0.216	* 0.196	** 0.336	1		
Overall creativity (5)	** 0.839	** 0.820	** 0.619	** 0.607	1	
Academic performance (6)	0.073	* 0.190	** 0.265	0.103	* 0.189	1

According to Table 6, creativity components have a positive and significant correlation coefficient with academic performance. However, there was no significant relationship only between expansion and fluidity with academic performance. Most of the correlation coefficients are low to medium according to the classification (small = 0.10-0.29, medium = 0.30-0.49, and large = 0.50-1) (Cohen, 1988,

quoted by Zarei, 2018). All the coefficients are in line with the theoretical foundations of the variables.

Table 7: Pearson correlation coefficients matrix among the main variables (n = 279)

Variables	(1)	(2)	(3)	(4)
Regulation of behavior (1)	1			
Metacognition (2)	** 0.745	1		
Creativity (3)	** 0.295	** 0.302	1	
Academic performance (4)	** 0.259	* 0.221	* 0.189	1

Both components of executive function have positive and significant coefficients. There is a moderate correlation between creativity and GPA. Moreover, the correlation coefficients between components of executive functions with creativity and GPA are positive and significant (Table 7).

2. Inferential data analysis

As all parametric statistical methods, the normality of the data distribution is one of the main assumptions of the structural equation modeling (SEM) method. According to statisticians, if the range of Skewness and Kurtosis indices is at the range -1 to +1, the data distribution is normal[13]. According to the data of descriptive statistics, the value of these two indices is in the range and thus the univariate normality of the variables is confirmed. Moreover, the linearity of the relationship between variables was examined through scatterplot matrices with the results showing that the graphs are elliptic and none of the relationships among the variables show any obvious deviation from linearity.

• Structural equations modeling (SEM)

The model of creativity measurement construct is shown in Figure (1).

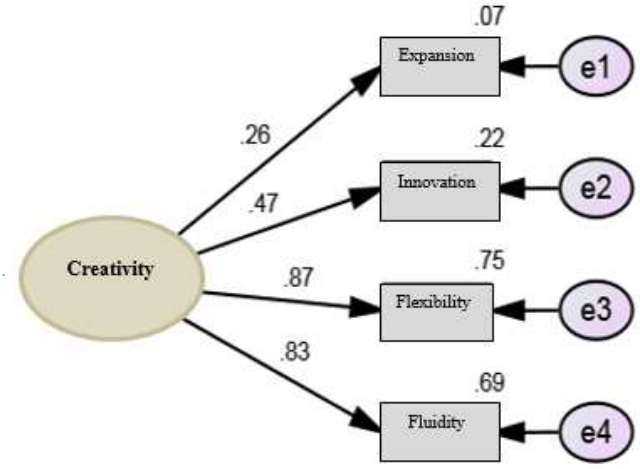

Figure 1: Measurement model of creativity

The table below shows the significant coefficients of the path between the marker or observation variables of creativity with the creativity construct:

Table 8: Significance of path coefficients between marker and creativity construct

From	to	Variable	b value	Error (S.E)	Critical ratio(C.R)	Sig. (P)
Creativity	→	Expansion	1.000			
Creativity	→	Creativity	0.877	0.359	2.443	0.015
Creativity	→	Flexibility	3.098	1.164	2.660	0.008
Creativity	→	Fluidity	3.513	1.313	2.675	0.007

There is a significant path coefficient between the markers or observational variables of creativity with the creativity construct (Table 8) and these variables can be included in SEM as the maker variable of creativity construct.

The structural measurement model of the executive function of eight indicator variables is given in Figure (2).

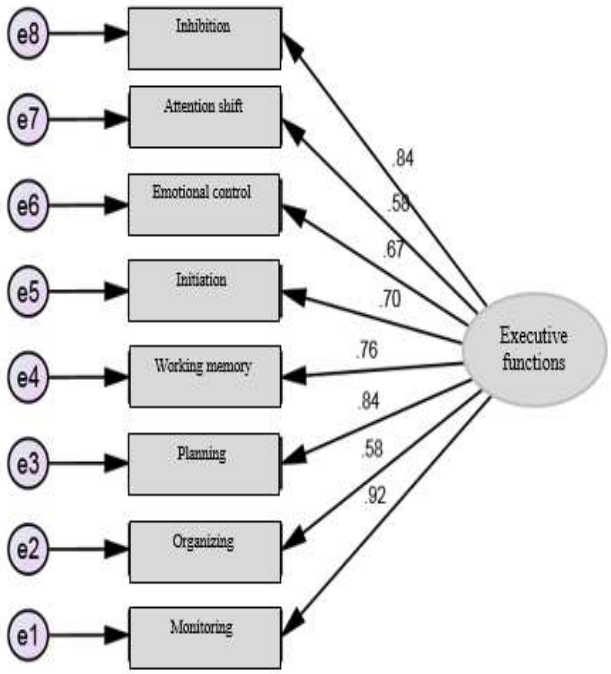

Figure 2: Measurement model of the executive function construct

Significance of coefficients of the path between marker or observational variables of executive function with executive function construct (Table 9) shows that all eight marker variables defined on executive function intelligence construct have significant value and can well measure current construct executive function.

Table 9: Significance of path coefficients between markers variables with executive function construct

From	To	Variable	b value	Error (S.E)	Critical ratio(C.R)	Sig. (P)
Executive function	→	Monitoring	1.000			
Executive function	→	Organizing	0.378	0.056	6.737	0.001
Executive function	→	Planning	1.273	0.103	12.321	0.001
Executive function	→	Working memory	0.801	0.080	10.014	0.001
Executive function	→	Imitation	0.573	0.064	8.958	0.001
Executive function	→	Emotional control	0.658	0.080	8.177	0.001
Executive function	→	Attention shift	0.622	0.093	6.685	0.001
Executive function	→	Inhibition	1.399	0.116	12.015	0.001

There are 29 variables in the structural model of the study, of which 13 are observable and the rest are latent variables. Moreover, 15 variables are considered as endogenous and 14 as endogenous variables.

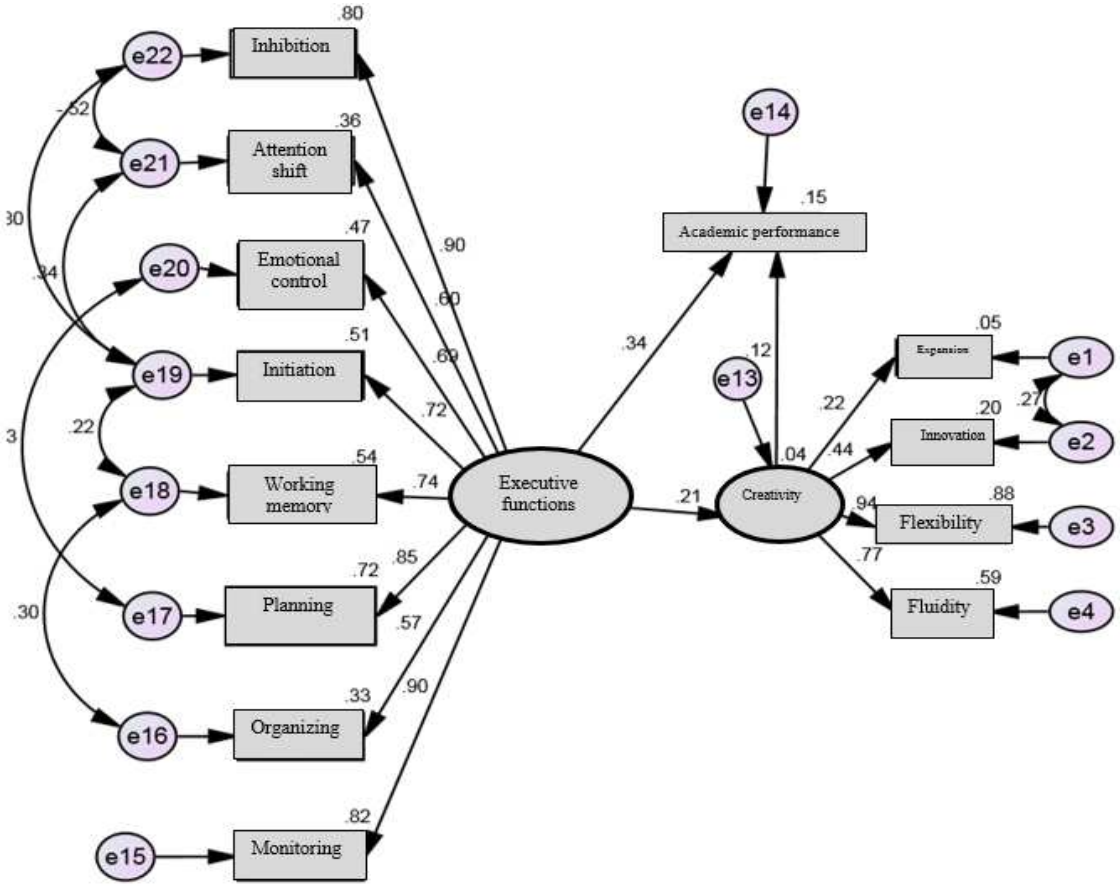

Figure 3: Research assumed model

The fitness indices of the initial model show that all fitness indices are close to the standard values of these indices. Thus, the assumed model of research fits well with the experimental data.

Table 10: Research model fitness indices

Fitness indices	(χ^2)	Df	/df$^2\chi$	RMSEA	GFI	AGFI	IFI	TLI	CFI
The initial model	204.84	63	3.25	0.138	0.81	0.73	0.83	0.78	**0.83**
Modified model	89.63	56	1.60	0.071	0.91	0.84	0.96	0.94	**0.96**
Acceptable value	**Close to zero**	-	**Under 3**	**<0.08**	**>0.90**	**>0.80**	**>0.90**	**>0.90**	**>0.90**

• Significant path coefficients between variables and existing constructs

Table 11: Significance of non-standard direct coefficients between the variables in the model

From	To	Variable	b value	Error (S.E)	Critical ratio(C.R)	Sig. (P)
Executive function	→	GPA	0.222	0.058	3.848	0.001
Executive function	→	Creativity	0.089	0.056	1.591	0.112
Creativity	→	GPA	0.185	0.161	1.149	0.250
Creativity	→	Expansion	1.000			
Creativity	→	Innovation	0.992	0.413	2.400	0.016
Creativity	→	Flexibility	4.005	1.778	2.253	0.024
Creativity	→	Fluidity	3.893	1.686	2.309	0.021
Executive function	→	Monitoring	1.000			
Executive function	→	Organizing	0.382	0.053	7.167	0.001
Executive function	→	Planning	1.301	0.095	13.643	0.001
Executive function	→	Working memory	0.785	0.076	10.275	0.001
Executive function	→	Initiation	0.595	0.062	9.558	0.001
Executive function	→	Emotional control	0.680	0.073	9.309	0.001
Executive function	→	Attention shift	0.641	0.087	7.337	0.001
Executive function	→	Inhibition	1.516	0.101	14.972	0.001

$p < 0.05$

According to the data in Table (11), the coefficient of the path between the executive function to GPA was significant at 0.05 level but the two coefficients of executive function to creativity and path coefficient between creativity to GPA were insignificant. Moreover, the path coefficients between the constructs and their marker variables were significant at the 0.05 level in all cases.

Table 12: Direct, indirect, and total standard effects of the main variables

From construct	To construct	Direct effect	Indirect effect	Total effect	Explained variance
Executive function	Creativity	0.212	Does not have	0.212	0.04
Executive function	Academic performance	0.343**	0.026	0.369**	0.15
Creativity	Academic performance	0.121	Does not have	0.121	

**p<0.01

The direct coefficients between the executive function construct to creativity were insignificant, but the coefficient of these constructs for academic performance was positive and significant at the 0.01 level (Table 12). However, the indirect coefficient of executive function construct to academic performance through the mediator variable creativity is insignificant. In other words, the mediating role of creativity is not confirmed.

All eight components of executive function were then tested in a separate model as independent variables.

• Inhibition and academic performance are correlated with the mediating role of creativity among secondary school students.

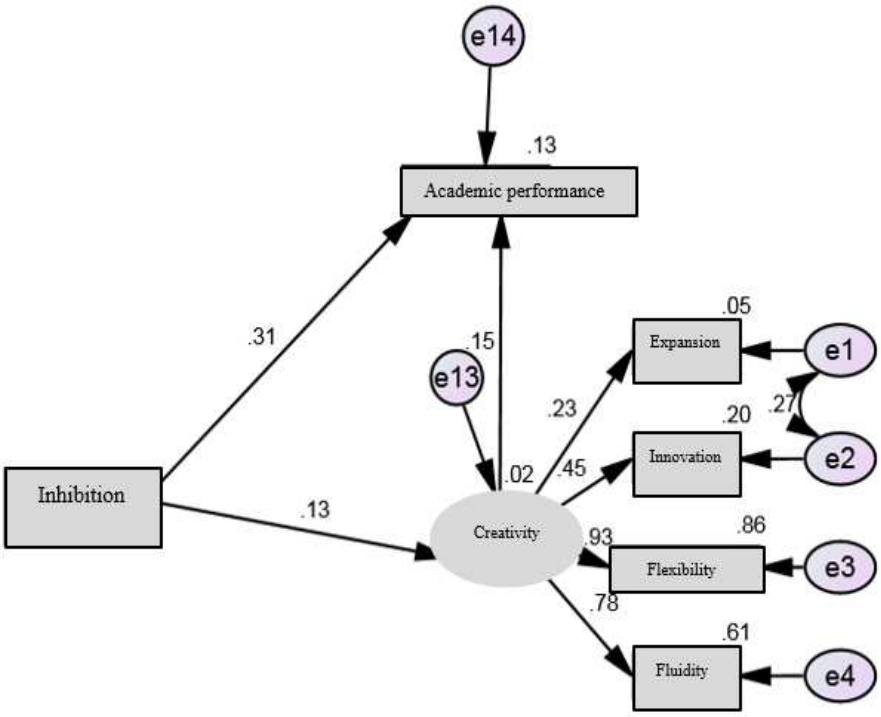

Figure 4: Inhibition model

Table 13: Inhibitory model fitness indices

Fitness Indices	(χ^2)	Df	/df$^2\chi$	RMSEA	GFI	AGFI	IFI	TLI	CFI
Initial model	12.89	7	1.84	0.08	0.96	0.90	0.96	0.91	0.96

Table 14: Significance of non-standard direct coefficients between the variables in the model

From	To	Variable	b value	Error (S.E)	Critical ratio(C.R)	Sig. (P)
Inhibition	→	GPA	0.120	0.033	3.621	0.001
Inhibition	→	Creativity	0.034	0.028	1.192	0.233
Creativity	→	GPA	0.228	0.168	1.356	0.175

• Orientation (attention shift) and academic performance are correlated with the mediating role of creativity among the secondary school students.

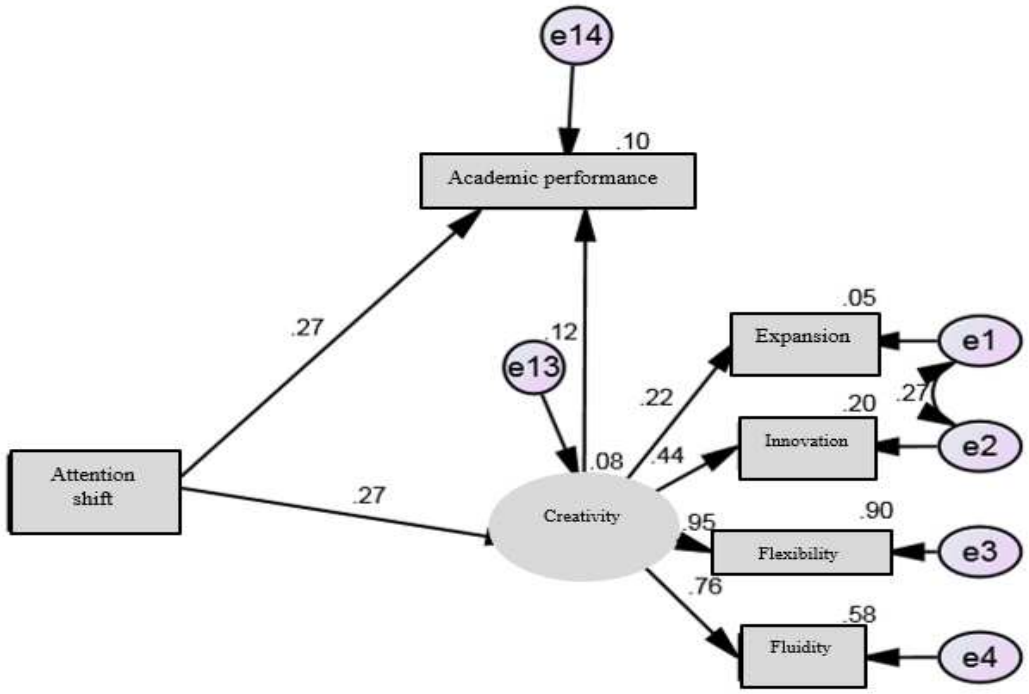

Figure 5: Attention shift model

Table 15: Fitness indices of attention shift model

Fitness indices	(χ^2)	Df	/df$^2\chi$	RMSEA	GFI	AGFI	IFI	TLI	CFI
Initial model	15.98	7	2.28	0.10	0.96	0.88	0.94	0.87	0.94

Table 16: Significance of non-standard direct coefficients between the variables in the model

From	To	Variable	b value	Error (S.E)	Critical ratio(C.R)	Sig. (P)
Attention shift	→	GPA	0.163	0.055	2.965	0.003
Attention shift	→	Creativity	0.109	0.060	1.828	0.068
Creativity	→	GPA	0.183	0.164	1.113	0.266

- **Emotional control and academic performance are correlated with the mediating role of creativity among secondary school students.**

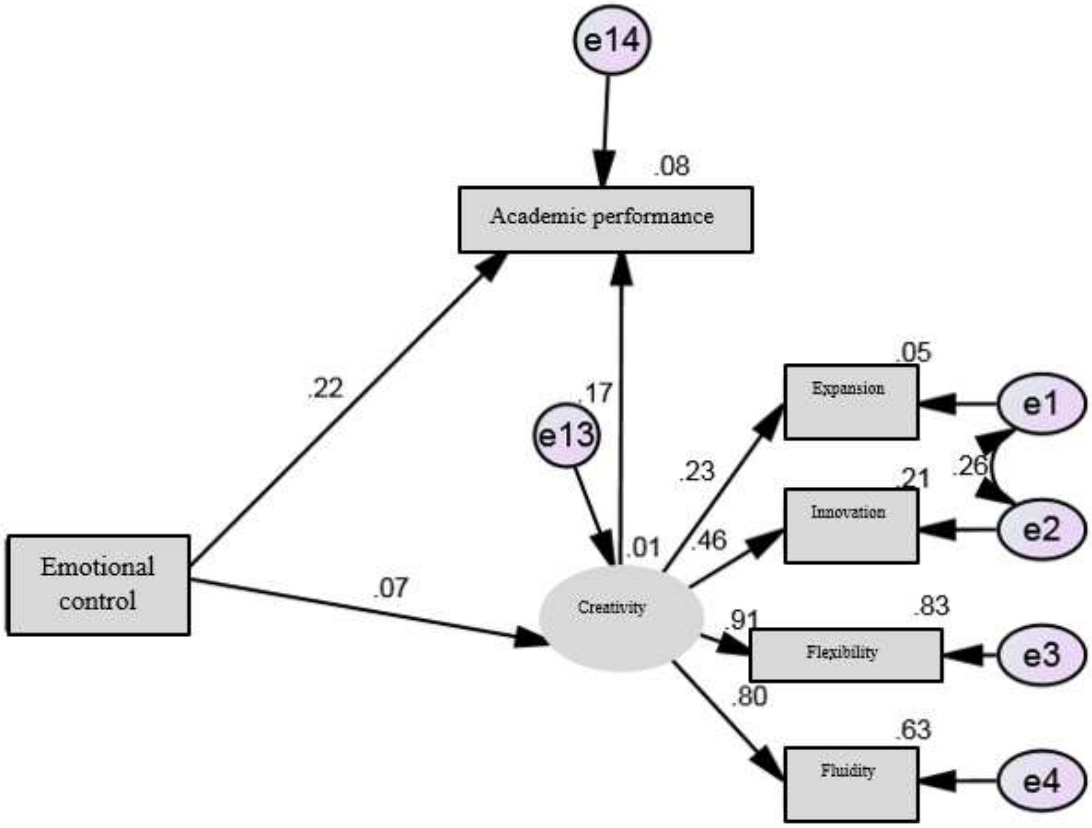

Figure 6: Emotional control model

Table 17: Fitness indices of emotional control model

Fitness Indices	(χ^2)	Df	/df$^2\chi$	RMSEA	GFI	AGFI	IFI	TLI	CFI
Initial model	8.34	7	1.19	0.04	0.98	0.93	0.99	0.98	0.99

Table 18: Significance of non-standard direct coefficients between the variables in the model

From	To	Variable/construct	b value	Error (S.E)	Critical ratio(C.R)	Sig. (P)
Emotional control	→	GPA	0.144	0.058	2.492	0.013
Emotional control	→	Creativity	0.033	0.046	0.712	0.476
Creativity	→	GPA	0.256	0.173	1.476	0.140

• Initiation of the task and academic performance are correlated with the mediating role of creativity among secondary school students.

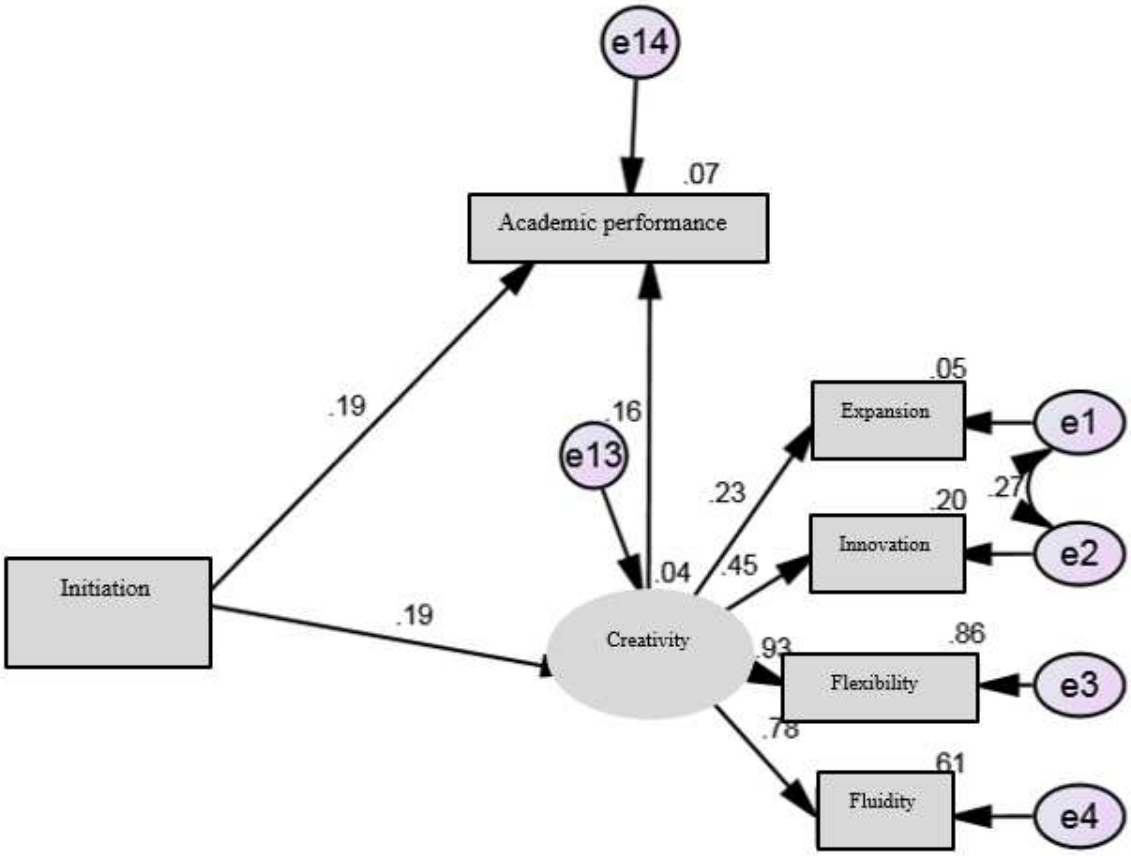

Figure 7: Initiation model

Table 19: Initial model fitness indices

Fitness Indices	(χ^2)	Df	/df$^2\chi$	RMSEA	GFI	AGFI	IFI	TLI	CFI
Initial model	9.76	7	1.39	0.058	0.97	0.93	0.98	0.96	0.98

Table 20: Significance of non-standard direct coefficients between the variables in the model

From	To	Variable/construct	b value	Error (S.E)	Critical ratio(C.R)	Sig. (P)
Initiation	→	GPA	0.150	0.071	2.120	0.034
Initiation	→	Creativity	0.102	0.066	1.543	0.123
Creativity	→	GPA	0.232	0.173	1.346	0.178

• Working memory and academic performance are correlated with the mediating role of creativity among secondary school students.

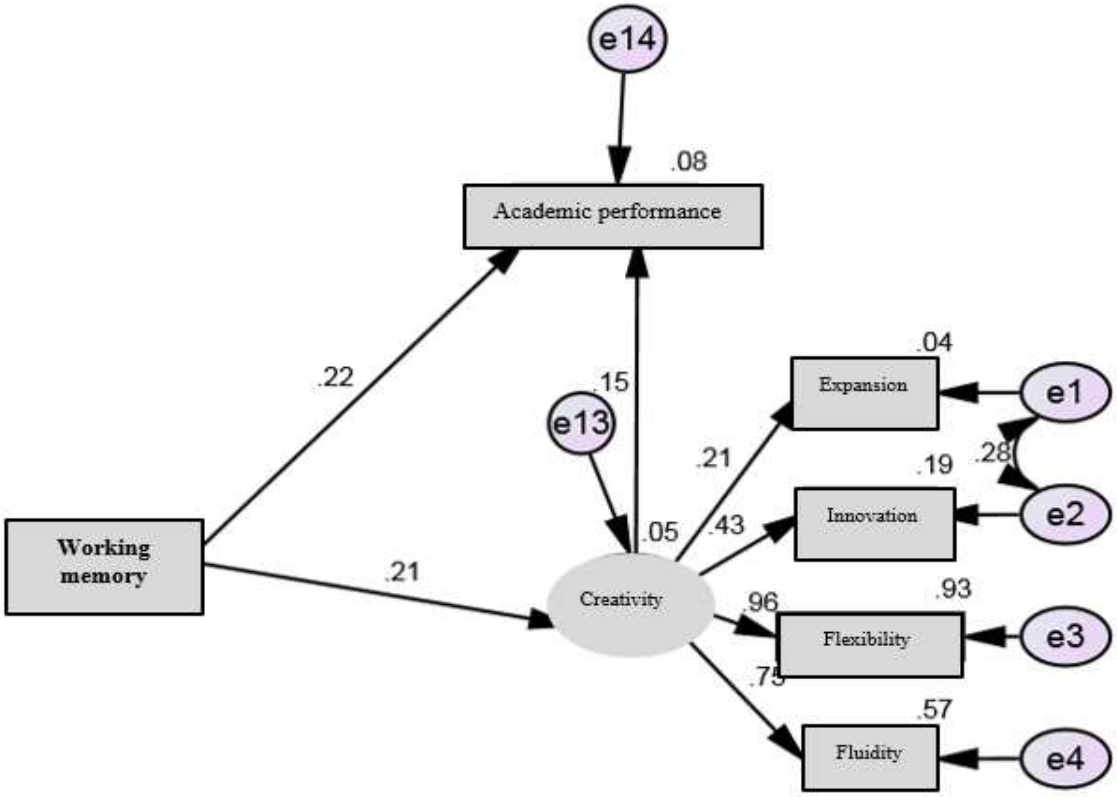

Figure 8: Working memory model

Table 21: Working memory model fitness indices

Fitness Indices	(χ^2)	Df	/df$^2\chi$	RMSEA	GFI	AGFI	IFI	TLI	CFI
Initial model	20.37	7	2.91	0.12	0.95	0.85	0.91	0.80	0.91

Table 22: Significance of non-standard direct coefficients between the variables in the model

From	To	Variable/construct	b value	Error (S.E)	Critical ratio(C.R)	Sig. (P)
Working memory	→	GPA	0.134	0.055	2.441	0.015
Working memory	→	Creativity	0.080	0.051	1.591	0.112
Creativity	→	GPA	0.235	0.182	1.290	0.197

• Planning and academic performance are correlated with the mediating role of creativity among secondary school students.

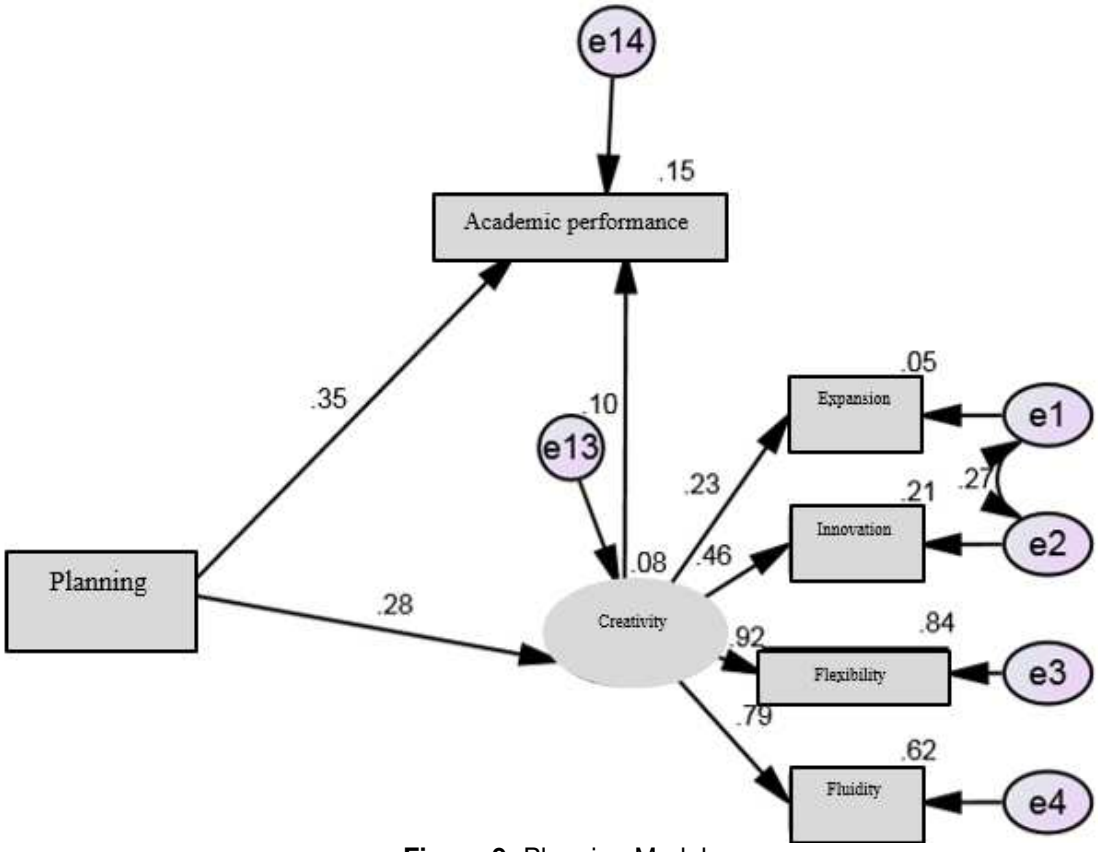

Figure 9: Planning Model

Table 23: Fitness indices of planning model

Fitness Indices	(χ^2)	Df	/df$^2\chi$	RMSEA	GFI	AGFI	IFI	TLI	CFI
Initial model	9.52	7	1.36	0.055	0.97	0.93	0.98	0.96	0.98

Table 24: Significance of non-standard direct coefficients between variables in the model

From	To	Variable/construct	b value	Error (S.E)	Critical ratio(C.R)	Sig. (P)
Planning	→	GPA	0.146	0.037	3.907	0.001
Planning	→	Creativity	0.079	0.043	1.850	0.064
Creativity	→	GPA	0.142	0.153	0.932	0.351

• Organizing and academic performance are correlated with the mediating role of creativity among secondary school students.

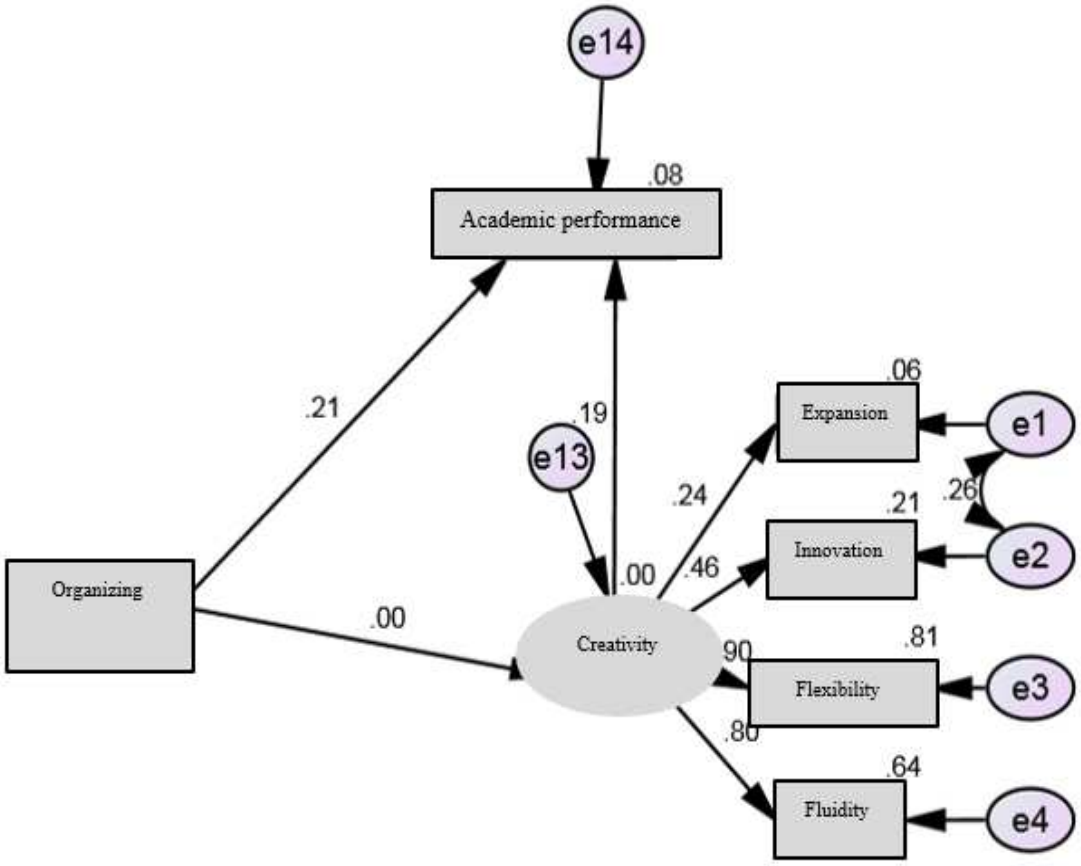

Figure 10: Organizing model

Table 25: Fitness indices of organizing model

Fitness Indices	(χ^2)	Df	/df$^2\chi$	RMSEA	GFI	AGFI	IFI	TLI	CFI
Initial model	1.67	7	1.52	0.066	0.97	0.91	0.97	0.94	0.97

Table 26: Significance of non-standard direct coefficients between the variables in the model

From	To	Variable/construct	b value	Error (S.E)	Critical ratio(C.R)	Sig. (P)
Organizing	→	GPA	0.202	0.086	2.345	0.019
Organizing	→	Creativity	-0.003	0.066	-0.049	0.961
Creativity	→	GPA	0.276	0.177	1.558	0.119

- **Monitoring (revision) and academic performance are correlated with the mediating role of creativity among secondary school students.**

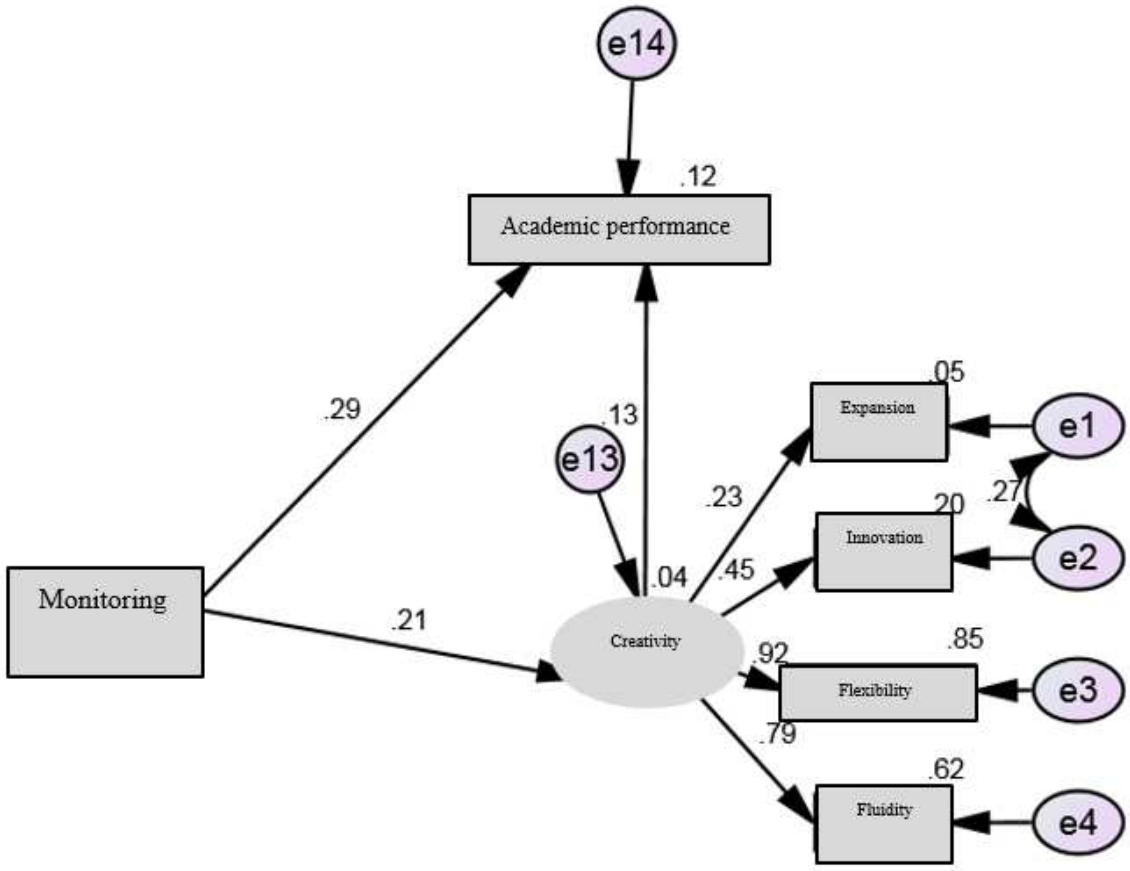

Figure 11: Monitoring model

Table 27: Fitness indices of the monitoring model

Fitness Indices	(χ^2)	Df	/df$^2\chi$	RMSEA	GFI	AGFI	IFI	TLI	CFI
Initial model	8.34	7	1.19	0.04	0.98	0.93	0.99	0.98	0.99

Table 28: Significance of non-standard direct coefficients between the variables in the model

From	To	Variable/construct	b value	Error (S.E)	Critical ratio(C.R)	Sig. (P)
Monitoring	→	GPA	0.172	0.052	3.321	0.001
Monitoring	→	Creativity	0.083	0.051	1.618	0.106
Creativity	→	GPA	0.194	0.161	1.201	0.230

As the tables above show, all models except the working memory model, with a relatively poor fit, have a good fit and the path coefficient of all components with the academic performance is significant. Moreover, no significant indirect coefficients were observed.

Conclusion

One of the significant issues in today's educational and psychological community is the executive functions of the brain. "Executive Functions" is a general term that encompasses all complex cognitive processes necessary in accomplishing goal-directed, difficult to new tasks (Hughes & Graham, 2000, quoted by Alizadeh, 2006)[14]. The set of executive functions affects each of us whether young and old. These functions affect our performance at school, work, emotional responses, personal relationships, and social skills. However, the executive functions emerge somehow differently in each of us: every person has weaknesses in some of its other areas. Executive function is a theory with more than twenty years passed since its development. The

interesting and controversial point of the theory is that it has become increasingly popular among practitioners who treat compulsive, impulsive, and obsessive-compulsive disorders [15].

Over the last decade, increasing attention has been paid to the role of executive function education in childhood because the development and proper training of executive functions have a key role in the social development, academic and educational success of the child (Blair, 2002, quoted from Firoozi, 2010).

According to the results, academic performance can be predicted through executive functions of the brain with the mediating role of creativity among high school students.

Given the model presented, there is a significant relationship between executive functions of the brain with academic performance, no significant relationship between executive functions of the brain with creativity and finally, and no relationship between creativity and academic performance. Moreover, in responding to whether creativity construct mediates the relationship between executive function and academic performance, one has to state that the mediating role of a variable occurs when the direct relationship of the variable to the principal dependent variable is significant. The direct coefficient of executive function with academic performance is significant yet the indirect coefficient between these two variables is insignificant (Table 12). Hence, one can state that the creativity construct does not mediate between these two variables and only the direct effect exists between these two variables.

These results are in line with those of Friedel and Rad (2006), Payo (2014), Hajilo et al. (2012), Baratian and Bejani (2013), Bani Mahd and Mehrian (2014), Babaei Amiri and Ashouri (2014), Hassanzadeh and Imanifar (2015) who stated no significant relationships between creativity and academic performance. However, the results were not in line with those of Olatuyi et al. (2010) and Zahbiyoun and Ahmadi (2009). Their results indicate that people with high academic performance have more creativity compared to those with poor academic performance. Moreover, in confirming the results concerning the lack of relationship between executive functions of the brain with creativity, one can cite the results of Dillon (2009) and Lee, and Triolet (2013), which are in line with the above results. Concerning the existence of significant relationship between executive functions and academic performance, one can state the results of Hassnavandi et al. (2016), stating that poor performance of brain executive functions or their impairment have a profound effect on adaptation and academic performance, Additionally, there were similar results in the studies of Stiken and Goush, Gavalda and Waltz that were consistent with our results[16].

Inhibition has a significant relationship with classroom performance, orientation (attention transfer) a significant relationship with academic performance, emotional control a significant relationship with academic performance, initiation a significant relationship with academic performance, and working memory a significant relationship with academic performance. Moreover, there is a significant relationship between planning and academic performance, a significant relationship between the organization and academic performance, and a significant relationship between monitoring and academic performance. Generally, the results showed that the path coefficient of all the components with academic performance was significant.

Academic performance is one of the most important criteria with a significant role in examining students' ability to complete their studies and go to higher levels. Thus, according to the results that confirm the effective role of brain executive functions concerning academic performance, one can state that as the forces of executive functions affect each of us whether young and old. These functions affect our performance at school, work, emotional responses, personal relationships, and social skills. Thus, one has to incorporate educational environments that enhance the performance of our brain functions to fulfill this important educational task, so that learning errors are minimized and academic performance reaches its highest level. Moreover, the significant and notable point is that since most executive functions start from an early age, it is more logical to develop and practice these functions from an early age to reach the highest outcome.

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