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The Correlational Relationship Between Electronic Game Addiction and Executive functions of the brain Among a Sample of Adolescent Students

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Abstract:

Electronic game addiction is a common issue nowadays and is considered a form of behavioral addiction with negative consequences. It affects adolescents' psychological, physical, cognitive, and social well-being. Most previous studies have shown a positive relationship between electronic games and functions of the brain, indicating that electronic game addiction can lead to chemical changes in the brain, particularly among different age groups, especially children and adolescents of both genders. Despite the growing interest in studying both electronic game addiction and executive functions of the brain, the majority of previous research has focused on individuals with developmental disorders, autism, or learning disabilities. Therefore, a research gap exists in exploring the relationship between electronic game addiction and executive functions of the brain among typically developing adolescents, particularly students in general education schools, who represent a vital segment in all societies, To the best of the researchers' knowledge, there are no Arab or international studies that have addressed the current research variables collectively within a single correlational framework among male and female students in intermediate and secondary schools in Saudi society. Therefore, the present study aims to investigate the nature of the correlational relationship between electronic game addiction and executive functions of the brain among adolescent students. The significance of this research lies in its potential to assist specialists in developing counseling programs for adolescents to reduce electronic game addiction and enhance executive functions of the brain among students across different educational stages, ultimately contributing to the development of an aware generation capable of advancing their society.

Keywords: Electronic Game Addiction - Executive functions of the brain - Adolescent Students.

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Introdcution:

In light of technological advancement, rapid successive changes, and digital transformation, the use of electronic games has become widespread among various groups across societies worldwide. The excessive engagement with these games has reached the level of addiction, particularly among children and adolescents. This addiction can lead to numerous health, psychological, emotional, and social problems. Moreover, it affects the brain and cognitive abilities and may impact the executive functions of the brain, especially in children and adolescents.

In this regard, the findings of Al-Enezi, 's (2020) study indicated that addiction to electronic games results in numerous negative social effects, including social withdrawal due to being preoccupied with electronic

games. Bashoushi, (2023) added that electronic games have a significant impact on the academic achievement of children and adolescents, as they negatively affect students' grades and academic performance.

Electronic game addiction is defined as "the excessive use of electronic games, which leads to the player experiencing numerous problems, yet continuing to play and being unable to control their excessive use of electronic games" (Lemmens, et al., 2009, p. 78). Electronic game addiction is considered a type of behavioral addiction, as it affects adolescents' mental, physical, psychological, and social well-being (Amer, et al., 2023, p. 215)

The American Psychiatric Association, in the Diagnostic and Statistical Manual of Mental Disorders (DSM), recognized 'Internet Gaming Disorder' and proposed nine diagnostic criteria for it. These criteria include: preoccupation, withdrawal, tolerance, loss of control, giving up other activities, continued use despite problems, deception, escape, and negative consequences. A diagnosis of Internet Gaming Disorder requires that at least five of these criteria be met within a one-year period Andre, F., et al., 2022).(

The current study adopts the definition of electronic game addiction as the preoccupation with electronic games and prioritizing them over social relationships with others, neglecting studying and academic duties, and experiencing pleasure while continuing to play for extended periods. This is often accompanied by a range of emotional reactions and driven by a strong desire to achieve in-game rewards or to escape real-life pressures. It also involves cognitive beliefs that associate gaming with feelings of achievement, expertise, challenge, and adventure (Asiri & Elamrousy, 2024).

The findings of Weinstein's study (2010, p. 268) indicated that electronic game addiction affects the brain by causing chemical changes that are associated with emotional, behavioral, and academic problems among students. Furthermore, the findings of Walter, et al.'s (2008) study revealed a positive relationship between electronic games and brain functions.

Executive functions are defined as a term that describes a set of cognitive abilities that govern and regulate an individual's capacities, behaviors, and planning when facing novel situations (Al-Dhafiri et al., 2020). It is worth noting that psychologists and neuroscientists use the concept of executive functions to identify the cognitive processes responsible for planning, cognitive flexibility, and abstract thinking (Abdel-Tawab, 2007). Executive functions of the brain are also defined as higher-order functions of the cerebral cortex, developing in coordination with the maturation of the prefrontal cortex (Al-Shuqairat, 2015).

Ahrens, et al. (2019) emphasized that executive functions lead to higher cognitive processes regulated by the frontal lobe of the brain. Tarabiya, (2018) added that the cerebral cortex has various functions, such as memory, language, emotional processing, and attention.

Moreover, executive functions are a hierarchical system of cognitive functions, consisting of planning, shifting, initiation, emotional regulation, monitoring, inhibition, working memory, and organization (Gioia, et al., 2005).

The current study adopts the definition of executive functions of the brain as mental skills that help individuals regulate their thoughts, emotions, and behaviors through their ability to plan—based on attention and perception—and their working memory capacity to process and accurately retain information, which are considered the "cool" components of executive functions. In addition, the individual's ability to regulate emotions and organize behaviors and social relationships represents the "hot" components of executive functions (Elamrousy & Asiri, 2024). The findings of Mohammed's (2018) study revealed that electronic game addiction leads to a decline in executive functions of the brain abilities, including attention, perception, and memory.

Numerous previous studies have addressed electronic game addiction. For example, the study by Al-Yaquob & Adbees, (2009) revealed that electronic game addiction may lead to the emergence of unusual behaviors and the abandonment of other duties and responsibilities. Hassan's (2017) study found

statistically significant differences between individuals who play electronic games, attributed to gender, on the social intelligence scale. The study by Abdel-Moneim & Othman, (2021) revealed a high prevalence rate of Internet Gaming Disorder among the study sample, with the rate being higher among males than females. Additionally, the study by Tina, et al. (2022) found that electronic games range between addiction and the occurrence of various physical injuries.

Several previous studies have also addressed executive functions of the brain. For example, the study by Durkin (2010) indicated that individuals with autism spectrum disorders enjoy electronic games, which positively affect their executive functions of the brain. The study by Welsh and Pennington (1988) found that executive functions of the frontal lobe in children operate through cognitive structuring. Additionally, Al-Shuqairat's (2015) study showed a high level of executive functions among university students, with no significant differences between males and females in the measured executive functions.

Previous studies examining the relationship between electronic games and executive functions of the brain have yielded varying results. For instance, the study by Jaeggi, et al., (2008) found that participants who played electronic games experienced an increase in working memory capacity, which is considered a core executive function. The study by Soutschek, et al., (2018) demonstrated that brain stimulation targeting the frontopolar cortex in participants who were willing to exert cognitive and physical effort to gain rewards led to an increase in the amount of effort exerted. Additionally, the study by Abdullah & Ibrahim, (2023) emphasized the importance of utilizing electronic games to activate brain regions responsible for various cognitive functions in order to enhance attention and improve social behavior in individuals with developmental disorders.

The review of previous studies reveals the widespread prevalence of electronic game addiction across various age groups, particularly among children and adolescents of both genders, with a higher prevalence among males. Executive functions of the brain have been examined in many studies involving children with autism, while only a few studies have focused on university students. Research addressing the impact of electronic games on executive functions of the brain has primarily been conducted on individuals with developmental disorders and autism. To the best of the researchers' knowledge, no Arab or international study has investigated the current research variables collectively among typically developing children and adolescents in the Saudi environment. Therefore, the present study emerged to explore the nature of the correlational relationship between electronic game addiction and executive brain functions among typically developing adolescent students. Accordingly, the research problem is formulated in the following main question: What is the relationship between electronic game addiction and executive functions of the brain among adolescent students? To answer this question, the current study aimed to test the following hypotheses**:**

There is a statistically significant correlation between electronic game addiction and executive functions of the brain among a sample of adolescent students in selected schools within the Saudi community.

There are statistically significant differences in the electronic game addiction scale scores among the sample members attributed to the gender variable (male – female).

There are no statistically significant differences in the executive functions of the brain scale scores among the sample members attributed to the gender variable (male – female).

The current study benefited from psychological literature and previous studies in determining the appropriate methodology, sample, constructing the research literature, and supporting its results. Therefore, the main aim of the current study is to explore the correlational relationship between electronic game addiction and executive functions of the brain among adolescent students. The importance of this study lies in the contemporary variables being examined, namely electronic game addiction and executive brain functions among adolescents in the Saudi community, a group that deserves attention. Furthermore, no study has specifically addressed this topic within the Saudi environment. The practical significance of this study lies in the results it yields, which will help specialists develop therapeutic plans and counseling programs to reduce electronic game addiction and enhance

executive functions of the brain among students at different educational stages, contributing to the development of a conscious generation that can uplift their community. This will also benefit future studies in this field.

Methodology:

The study employed the descriptive correlational and comparative approach due to its suitability for the nature of this research. The main sample consisted of (409) students, including (179) males and (230) females, with ages ranging from (12 to 20) years. The average age was (16.38) years, with a standard deviation of (1.38). The study tools were applied to this sample during the 2024 academic year. The psychometric properties of these tools were verified using a pilot sample of (30) male and female students who shared the same demographic characteristics as the main sample. The tools used were the Electronic Game Addiction Scale and the Executive functions of the brain Scale, as follows:

Electronic Game Addiction Scale: The scale was developed by Asiri, A. and Elamrousy, N. (2024) and administered to a sample of adolescent students from several schools in Saudi Arabia, totaling (181) male and female students. The scale consists of (29) items distributed across five main dimensions: social and interpersonal dimension, academic and educational obligations, emotional and affective dimension, behavioral and addictive dimension, and cognitive dimension and its impact on thinking. All items in the scale are positively worded.

For scoring the scale, a three-point "Likert" scale was used with weighted response options as follows: "Applies" (3 points), "Sometimes" (2 points), and "Does not apply" (1 point). A score of (87) indicates a high level of electronic game addiction among the individuals in the current sample, while a score of (29) indicates a low level of addiction.

The developers of the scale assessed its validity and reliability, and the results demonstrated that the Electronic Game Addiction Scale possesses a high degree of validity and reliability. In the current study, the psychometric adequacy of the scale was further verified by assessing its validity and reliability using several different statistical methods, as follows:

-Validity1

The researchers sought to verify the internal consistency validity of the scale by conducting a correlation analysis between the scores of individual items and the total score of the corresponding sub-dimension to which each item belongs. In addition, correlations were calculated between the scores of the sub-dimensions and the total score of the entire scale. The results of these analyses are presented in Tables (1) and (2) below:

Table 1: Correlation Coefficients Between the Scores of Each Item and the Total Score of Their Respective Dimensions on the Electronic Game Addiction Scale

Dimension	Item No.	Correlation Coefficient	Dimension	Item No.	Correlation Coefficient
Social and personal relationships	1	**0.85	Academic and study commitments	1	**0.76
	2	**0.84		2	**0.67
	3	**0.79		3	**0.79
	4	**0.70		4	**0.80
	—	—		5	**0.74

Dimension	Item No.	Correlation Coefficient	Dimension	Item No.	Correlation Coefficient
	—	—		6	**0.86
emotional and affective	1	**0.58	Behavioral and addictive	1	**0.87
	2	**0.72		2	**0.87
	3	**0.74		3	**0.86
	4	**0.81		4	**0.82
	5	**0.79		5	**0.84
	6	**0.71		6	**0.74
	—	—		7	**0.76
Cognitive and influence on thinking	1	**0.90			
	2	**0.77			
	3	**0.76			
	4	**0.86			
	5	**0.85			
	6	**0.76			

**** indicates statistical significance at the (0.01) level**

Table 2: Correlation Coefficients Between the Total Score of Each Dimension and the Overall Score of the Electronic Game Addiction Scale

Dimension	Correlation coefficient of the scale
Social and personal relationships	**0.89
Academic and study commitments	**0.84
emotional and affective	**0.86
Behavioral and addictive	**0.93
Cognitive and influence on thinking	**0.82

**** indicates statistical significance at the (0.01) level**

The data in Tables (1) and (2) confirm the internal consistency validity of the scale. The correlation coefficients between each item and its corresponding sub-dimension were statistically significant at the (0.01) level, ranging from (0.58) to (0.90). This indicates that the items are consistent with the theoretical

dimension they were designed to measure, with no items requiring deletion or modification due to weak or statistically insignificant correlations.

The correlation coefficients between the sub-dimensions and the total score of the scale also showed strong and statistically significant relationships at the (0.01) level, ranging from (0.82) to (0.93). This reflects the coherence of these dimensions with the overall construct of the scale.

- Reliability:2

The researchers assessed the reliability of the scale by calculating Cronbach's alpha coefficient for each sub-dimension individually, as well as for the entire scale. Table (3) presents the results of the calculated reliability coefficients:

Table 3: Reliability Coefficients of the Electronic Game Addiction Scale for Adolescent Students

Dimensions		**Reliability coefficient (Cronbach's alpha)**
1	Social and personal relationships	0.81
2	Academic and study commitments	0.86
3	emotional and affective	0.82
4	Behavioral and addictive	0.92
5	Cognitive and influence on thinking	0.89
The scale as a whole		0.92

The results in Table (3) show that the reliability coefficients (Cronbach's alpha) for the dimensions of the Electronic Game Addiction Scale ranged from (0.81) to (0.92), all of which fall within the scientifically acceptable range. The overall reliability coefficient of the scale was (0.92), indicating that the scale possesses a high level of reliability, making it suitable for accurately and consistently measuring electronic game addiction among adolescent students.

Executive functions of the brain Scale: The scale was developed by Elamrousy, N. & Asiri, A. (2024) and administered to a sample of adolescent students from several schools in Saudi Arabia, totaling (181) male and female students. The scale consists of (24) items, which fall under four dimensions: planning, working memory, control and monitoring, and inhibition and shifting. All items in the scale are positively worded.

For scoring the scale, a three-point "Likert" scale with weighted response options was used: "Applies" (3 points), "Sometimes" (2 points), and "Does not apply" (1 point). A score of (72) indicates a high level of executive functions of the brain among the individuals in the current sample, while a score of (24) indicates a low level of executive functions of the brain.

The developers of the scale assessed its validity and reliability, and the results showed that the Executive functions of the brain Scale possess a high degree of validity and reliability. In the current study, the psychometric properties of the scale were further verified by calculating its validity and reliability using several different statistical methods, as follows:

- Validity:1

Internal consistency of the scale was verified by calculating the correlation coefficients between each item and the total score of the sub-dimension to which the item belongs. In addition, correlation coefficients were calculated between each sub-dimension and the total score of the entire scale. The results of these analyses are presented in Tables (4) and (5) below:

Table 4: Correlation Coefficients Between the Scores of Each Item and the Total Score of Their Respective Dimensions on the Executive functions of the brain Scale

Dimension	Item No.	Correlation Coefficient	Dimension	Item No.	Correlation Coefficient
Planning and Organization	1	*0.42	Working Memory	1	**0.66
	2	**0.61		2	**0.61
	3	**0.80		3	*0.37
	4	**0.85		4	**0.74
	5	**0.72		5	**0.63
	6	**0.82		6	**0.80
	———	———		7	**0.60
Control and Monitoring	1	**0.74	Cessation and conversion	1	*0.78
	2	**0.68		2	*0.66
	3	**0.62		3	*0.83
	4	**0.67		4	**0.56
	5	**0.75		5	**0.71
	6	**0.74		———	———
	———	———		———	———

*** indicates statistical significance at the (0.01) level. ** indicates statistical significance at the (0.01) level.**

Table 5: Correlation Coefficients Between the Total Score of Each Dimension and the Overall Score of the Executive functions of the brain Scale

Dimension	Correlation coefficient of the scale
Planning and Organization	**0.63
Working Memory	**0.89
Control and Monitoring	**0.77
Cessation and conversion	**0.81

. ** indicates statistical significance at the (0.01) level

The data in Tables (4) and (5) indicate that the scale has achieved internal consistency validity. The correlation coefficients between each item and its corresponding dimension were statistically significant, ranging from 0.37 to 0.85. This suggests that the items are consistent with the dimensions under which they fall. No items showed weak or statistically insignificant correlations that would warrant deletion or modification, which further supports the scale's validity in terms of internal consistency.

– Reliability:2

The researchers assessed the reliability of the scale by calculating Cronbach's alpha coefficient for each sub-dimension individually, as well as for the entire scale. Table (6) presents the results of the calculated reliability coefficients:

Table 6: Reliability Coefficients of the Executive functions of the brain Scale

Dimensions		**Reliability coefficient (Cronbach's alpha)**
1	Planning and Organization	0.80
2	Working Memory	0.74
3	Control and Monitoring	0.79
4	Cessation and conversion	0.74
The scale as a whole		0.78

The results in Table (6) show that the reliability coefficients, as measured by Cronbach's alpha, ranged from (0.74) to (0.80) across the sub-dimensions of the scale. The overall reliability coefficient was (0.78), which falls within the scientifically acceptable range. These findings indicate that the scale possesses a high degree of internal consistency, enhancing its reliability for accurately and consistently measuring executive functions of the brain.

Results

First hypothesis: The

There is a statistically significant correlational relationship between electronic game addiction and executive functions of the brain among a sample of adolescent students in some schools within the Saudi community. To test this hypothesis, Pearson's correlation coefficient was used to examine the relationship between electronic game addiction and executive functions of the brain. The results are presented in Table (7) below:

Table 7: Pearson Correlation Coefficient Between Electronic Game Addiction and Executive functions of the brain Among Adolescent Students

variable	**Executive Brain Functions**	**Significance level**
Electronic Game Addiction	**0.09−**	***0.042**

The results of the Pearson correlation analysis revealed a statistically significant inverse relationship at the (0.05) significance level between Executive functions of the brain and electronic game addiction, with a correlation coefficient of (-0.086).

The Second hypothesis:

There are statistically significant differences in the sample's scores on the Electronic Game Addiction Scale attributable to gender (males – females). To test this hypothesis, the researchers used an

independent-samples t-test to examine the significance of differences between the mean response scores on the Electronic Game Addiction Scale according to gender. The results are presented in Table (8) below:

Table 8: Results of the t-Test for Differences Between Mean Response Scores on the Electronic Game Addiction Scale

Dimension/Variable	Groups	Number	Mean	Std. Deviation	df.	T-value	Significance level
Social and personal relationships	Male	179	1.83	0.67	407	**4.03	0.00)Sig.(
	Female	230	1.58	0.59			
Academic and study commitments	Male	179	1.71	0.67	407	**6.31	0.00)Sig.(
	Female	230	1.34	0.50			
emotional and affective	Male	179	1.97	0.66	407	**5.16	0.00)Sig.(
	Female	230	1.66	0.58			
Behavioral and addictive	Male	179	1.85	0.71	407	**5.95	0.00)Sig.(
	Female	230	1.47	0.58			
Cognitive and influence on thinking	Male	179	2.15	0.65	407	**5.65	0.00)Sig.(
	Female	230	1.78	0.64			
Total Score (Electronic Game Addiction)	Male	179	1.91	0.60	407	**6.15	0.00)Sig.(
	Female	230	1.56	0.52			

. ** indicates statistical significance at the (0.01) level

The results of the t-test revealed statistically significant differences at the (0.01) significance level between males and females across all dimensions of the Electronic Game Addiction Scale, as well as in the total score. These differences consistently favored males.

The third hypothesis:

"There are no statistically significant differences in the scores of the sample on the Executive functions of the brain Scale attributable to the gender variable (male – female)". To test this hypothesis, the researchers used an independent samples t-test to examine the significance of the differences between the mean scores on the Executive functions of the brain Scale according to gender. The results are presented in Table (9) below:

Table 9: Results of the t-Test for the Significance of Differences Between Mean Scores on the Executive functions of the brain Scale

Dimension/Variable	Groups	Number	Mean	Std. Deviation	df.	T-value	Significance level

Planning and Organization	Male	179	2.65	0.32	407	**2.80	0.005)Sig.(
	Female	230	2.56	0.36			
Working Memory	Male	179	2.50	0.41	407	0.36−	0.72)Not sig.(
	Female	230	2.52	0.35			
Control and Monitoring	Male	179	2.56	0.41	407	0.03−	0.98)Not sig.(
	Female	230	2.57	0.42			
Cessation and conversion	Male	179	2.59	0.38	407	0.09	0.10)Not sig.(
	Female	230	2.53	0.41			
Total Score (Executive Brain Functions)	Male	179	2.58	0.32	407	0.09	0.27)Not sig.(
	Female	230	2.54	0.29			

. ** indicates statistical significance at the (0.01) level

The results of the t-test measuring gender differences on the dimensions of executive functions of the brain revealed statistically significant differences at the (0.01) significance level in one dimension only—Planning and Organization—with males scoring a higher mean (2.65) than females (2.56), (t = 2.80).

Discussion:

The results of the **first hypothesis** indicated a statistically significant inverse correlation between the two variables, whereby a lower level of executive functions of the brain was associated with a higher level of electronic game addiction—though the correlation was weak among adolescent students. These findings are consistent with the results of studies such as Mohamed (2018), which found that electronic game addiction weakens executive functions of the brain; Walter et al. (2008), which showed a positive relationship between electronic games and brain functions; and Weinstein (2010), whose results indicated that electronic game addiction affects the brain. However, the findings of the first hypothesis differ from those of some previous studies, such as Jaeggi et al. (2008), which found that participants who played electronic games had an increased working memory capacity—a key executive functions of the brain —and Soutschek et al. (2018), whose results showed that brain stimulation targets the frontopolar cortex in individuals who demonstrate a readiness to exert cognitive and physical effort to earn rewards. The researchers believe that the variation in study findings confirms that electronic games have both positive and negative effects on individuals who play them.

The results of the **second hypothesis** also showed that males had higher means than females on the overall Electronic Game Addiction Scale as well as on all of its dimensions. This indicates that males are more prone to electronic game addiction than females. This result is consistent with previous studies such as Abdel-Moneim and Othman (2021), whose findings revealed a higher prevalence of Internet Gaming Disorder among males than females, and Hassan (2017), which found statistically significant differences in electronic game use attributable to gender.

These findings appear logical, given that males are generally more inclined to engage in various types of games, especially electronic ones. While females may also have an increasing interest in electronic games in the age of technology, they tend to occupy themselves with a wider range of interests. However, the degree of engagement among males—particularly children and adolescents—is often more excessive.

The results of the **third hypothesis** also indicated that males demonstrated a relatively higher level in the planning and organization dimension compared to females. However, the other dimensions—working memory, inhibition and shifting, and monitoring and control—as well as the total score on the scale, did not show statistically significant differences attributable to the gender of the adolescent students.

This result may be explained by the notion that males tend to possess cognitive abilities that support planning and organizing when confronting new life situations, often in bolder ways due to the nature of their personalities, compared to females who often require support and assistance in many aspects of life. This supports the definition provided by (Al-Dhafiri, et al., 2020), who describe executive functions of the brain as a set of cognitive abilities that regulate and manage individual behaviors and planning when faced with new situations. Additionally, the results of the third hypothesis are partially consistent with the findings of (Al-Shuqairat, 2015), which indicated no significant gender differences in executive functions of the brain. The researchers believe that these results indicate no significant differences in executive functions of the brain between males and females who play electronic games, except for a difference in the ability to plan and organize—attributable to males' greater boldness in confronting new situations compared to females.

Conclusion:

The present study aimed to explore the nature of the correlation between electronic game addiction and executive functions of the brain among adolescent students, as well as to identify gender-based differences in scores on the Electronic Game Addiction Scale and the Executive functions of the brain Scale. The results revealed a statistically significant negative correlation between the two variables, indicating that a lower level of executive functions of the brain is associated with a higher degree of electronic game addiction, albeit to a weak extent, among adolescents. Additionally, statistically significant gender differences were found at the (0.01) level in one dimension of executive functions of the brain —planning and organization—with males scoring higher than females. The findings also indicated that males are more susceptible to electronic game addiction than females.

The current study aimed to reveal the nature of the correlation between electronic game addiction and the executive functions of the brain among adolescent students, and to reveal differences in the sample members' scores on both the electronic game addiction and executive functions of the brain scales according to the gender variable (males – females). The results resulted in a statistically significant inverse correlation between the two variables, whereby a decline in the level of executive functions of the brain is accompanied by an increase in the degree of addiction to electronic games to a weak degree among adolescent students. There are statistically significant differences at the significance level (0.01) between males and females on the dimensions of the executive functions of the brain in one dimension, which is (planning and organization). The results also showed that males are more susceptible to addiction to electronic games than females. In light of the findings, the study recommends that officials intensify awareness efforts regarding the risks of electronic games to protect adolescents. It also suggests organizing training programs to educate students in general education stages about the dangers of excessive gaming on the brain's executive functions.

Furthermore, one of the key implications of the current research is to draw the attention of professionals in the general education sector to the importance of developing preventive guidance programs that focus on adolescents, their behavior, and mental health, in order to produce capable and constructive members of society. The study also calls for further research, such as evaluating the effectiveness of guidance programs aimed at improving and developing executive functions of the brain among adolescents who engage in compulsive and excessive electronic gaming.

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