

Study on the effects of chess practice on the intellectual/mental development of 11-12 years old children

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Abstract

Background. The conclusions of some studies and research carried out over time have highlighted the beneficial effects that chess brings to the development of the mental capacities and thinking functions of the practitioners.

Aims. The purpose of the study was to evaluate the effects of chess practice in the intellectual/mental development of 11-12 year old students. In the 2022-2023 school year, the experimental group studied the optional subject "Education through Chess", and the control group studied another optional subject.

Methods. The experimental research was carried out on a sample of 47 5th grade students from four educational units in Gorj County. The evaluation (assessment) tools were the following four validated and approved tests: the Mathematical Calculation test; the Mathematical Reasoning test; the Text Comprehension test; the Analytical Reasoning test. The quantitative analysis of the obtained results was carried out in the SPSS program version 23.

Results. The results of our research highlight the fact that, at the end of the experiment, there were significant differences between the scores obtained by the subjects of the two groups, Sig. (2-tailed) < 0.05, in favor of the experimental group.

Conclusions. The 11-12-year-old students who studied the subject "Education through Chess" made significant progress in intellectual/mental development and thinking functions.

Keywords: education, optional subject, chess, intellectual/mental development.

Abbreviations: MC-the Mathematical Calculation test; MR-the Mathematical Reasoning test; TC-the Text Comprehension test; AR-the Analytical Reasoning test.

Introduction

Chess is considered to be the most popular mind games in the world with a history of over 1300 years. Chess is an amotric game, a common game, a universal game, where no particularities of age, sex, race, nationality or disability apply.

E. Ghindă defines chess as "a game, designed in the form of a sports fight, between two opponents who face each other with the power of their minds" (Ghindă, 1994).

Practicing the game of chess constitutes a gymnastics of the intellect that has the ability to stimulate and maintain the mental capacities of anyone, of any age, profession and social condition" (Dumitrescu, 2012). The conclusions of some studies and research carried out over time have highlighted the beneficial effects that chess brings to the development of the mental capacities and thinking, cognitive-sensory, cognitive-superior and, even the regulatory ones, of the practitioners (Christiaen, 1975; De Groot, 1994; Liptrap, 1998; Scholz et al., 2008; Sala et

al., 2015; Trincherro & Sala, 2016; Güneş & Tuğrul, 2017; Sala & Gobet, 2017; Shahar & Avital, 2020; Tanajyan & Tanajyan, 2023). Vlad Ardeleanu declared in 2008 for Career Magazine that "Chess helped me organize my mind, formed a strategic way of thinking. Chess, in fact, is based on two essential elements: strategy and tactics. Tactics are the rules of the game, which everyone must know, and strategy is that superior element that makes the difference." (Gheorghiu, 2008).

Children's intellectual development is achieved gradually, knowledge and understanding abilities vary according to age (1). The age of 11-12 years represents the stage of concrete operations, a period in which logical and organized thinking appears. At this age, the child has the ability to perform various classification tasks, to arrange objects in a natural order and to understand the principle of conservation. At this age, thinking is less deductive and egocentric.

In the framework plan for secondary education, the optional subject "Education through chess" is among the

Received: 2023, November 7; Accepted for publication: 2023, November 15

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<https://doi.org/10.26659/pm3.2023.24.4.190>

examples of electives currently promoted at national level. (2). „The curriculum of the optional discipline Education through Chess has the role of facilitating the transition from approaching chess as a game, to approaching it as a science, with the help of its own methodology, based on observation, information gathering, exercise, problematization, prediction, planning. By going through the stages of learning chess, children accumulate and highlight skills useful to life and integration into school life”(3).

The optional subject „Education through chess” was introduced in pre-university education starting with the school year 2014-2015 following the signing of the collaboration protocol on the development of the National Program „Education through chess in pre-university education” between MEN and FRS (4). It aims at implementing the optional discipline „Education through chess” and training and specialization of teachers for teaching chess in school (5).

„Puberty, like adolescence - specific to the second decade of a person’s life - is characterized by the transition to maturation and integration into adult society, with its social, political, family, professional, etc. demands. This path is all the more winding, the more complicated social life is” (Șchiopu & Verza, 1997).

The preadolescent at this age stage comes into contact with „varied and profound knowledge, and thinking develops to the capacity of the real, parental insufficiencies no longer go unnoticed” (Dragu & Cristea, 2002). „It is during this period that logical, formal thinking begins to consolidate. Some students are quicker in this acquisition than others. But it is not mandatory that this capacity, once formed, is always followed and active in any situation or for any type of content” (Cosmovici & Iacob, 1999).

During puberty, the complex intellectual activity is carried out under the sign of the development of logical-formal structures and the expansion of the volume of concepts used, in which the critical spirit takes shape, causing the adolescent to strengthen values compared to non-values and demonstrate explicit attitudes towards ignorance and incompetence. Even if girls are more mature and more diligent, they do not exceed the intellectual development of boys and are more tolerant towards some non-achievements of peers or adults, they often stand out in those subjects that involve more complex verbal expressions, while boys are better at exact and technical sciences, because the operations of thinking and its qualities are in the whole process of consolidation by maintaining the intellect with as rich, abstract and complex information as possible (Șchiopu & Verza, 1997).

It was assumed that by practicing chess, one hour/week in the 2022-2023 school year, through the introduction of the optional discipline, „Education through chess” in the CDS, for 5th grade students, 11-12 year old children, would improve their level of intellectual development and thinking functions.

Hypothesis

Starting from the premise that the game of chess develops mental processes and functions of thinking, we submit for research the following hypothesis: by practicing

chess as an optional subject, during a school year, we can obtain long-term effects in the intellectual/mental development of students.

Material and methods

This study has obtained the approval of the Ethics Commission. Before starting the experimental research, the parents’ standard agreements on pupils’ participation in experimental research were signed. The subjects also expressed their agreement to participate in this research.

Research protocol

In the study, in order to validate the working hypothesis we used the following research tools:

- The collaboration protocol between the University of Pitesti, a doctoral studies accredited institution, the Doctoral School Science of Sports and Physical Education and the Gorj County School Inspectorate.

- The collaboration protocol between the University of Pitesti, PhD studies institution, the Doctoral School Science of Sport and Physical Education and Aninoasa Secondary School, Aninoasa, Gorj County.

a) Period and place of the research

The experimental research was conducted between September 2022 and June 2023. The tests were applied in two stages, at the beginning of the school year in Module 1 - initial test (Ti) and at the end of the school year in Module 5 - final test (Tf).

The 2022-2023 school year had 36 weeks, started on September 05, 2022 and ended on August 31, 2023, being structured in five modules, as follows:

Module 1 - courses - from Monday, September 5, 2022, to Friday, October 21, 2022;

- Holiday - from Saturday, October 22, 2022, to Sunday, October 30, 2022;

Module 2 - courses - from Monday, October 31, 2022, to Thursday, December 22, 2022;

- Holiday - from Friday, December 23, 2022, to Sunday, January 8, 2023;

Module 3 - courses - from Monday, January 9, 2023, to Friday, February 3, 2023; at the decision of the Gorj County School Inspectorate;

- Holiday - from Saturday, February 11, 2023, to Sunday, February 19, 2023, at the decision of the Gorj County School Inspectorate;

Module 4 - courses - from Monday, February 20, 2023, at the decision of the Gorj County School Inspectorate, until Thursday, April 6, 2023;

- Holiday - from Friday, April 7, 2023, to Tuesday, April 18, 2023;

Module 5 - courses - from Wednesday, April 19, 2023, to Friday, June 16, 2023;

- Holiday - from Saturday, June 17, 2023, to Sunday, September 3, 2023.

In accordance with ORDER No. 3.505 of March 31, 2022 on the structure of the school year 2022-2023 (6).

The experimental research was carried out within the four educational units in which the study students were enrolled. Tests and questionnaires were applied in the classroom, in a quiet place, away from noises, respecting all conditions of administration and testing of subjects. These were applied by the physical education and sports

teacher of the class and by the school counselor of the respective school.

b) Subjects and groups

The experimental research was carried out on a sample of 47 5th grade students from four educational units in Gorj county (15 students - the experimental group and 32 students - the control group). Children from the experimental group completed the optional discipline "Education through Chess".

c) Applied tests

The evaluation tools were four validated and approved tests: the Mathematical Calculation test (MC); the Mathematical Reasoning test (MR); the Text Comprehension test (TC); the Analytical Reasoning test (AR). The four applied tests are part of the Manual of Cognitive Aptitude Tests. All this applies from the age of 12.

- MC - measures the subject's ability to perform mathematical calculations. The test consists of a set of 15 simple mathematical exercises of addition, subtraction, multiplication and division by natural numbers. The task of the subjects is to perform the calculations and choose the correct answer variant from the four given alternative variants.

- MR - measures the subject's ability to make mathematical reasoning. The test consists of 20 exercises. The exercises have a progressive degree of difficulty. Each exercise consists of a string of ordered numbers. The strings are drawn up based on one, two or three rules of formation. Two numbers are missing from each string, their location is marked with two dashes. The first 10 exercises are developed according to a single rule of ordering numbers. The next nine are formed by overlapping two strings, and the last exercise consists of overlap ping three strings.

- TC - measures the subject's ability to construct

meaning and generate inferences (measures the ability to understand written texts).The comprehension test consists of three passages of text. With each text the degree of difficulty increases progressively. In order to answer as many strategies and operations as possible for understanding the texts, the test comprises one narrative text and two texts with expository structure. The expository text calls for more elaborate strategies of understanding that are different from the strategies involved in processing narrative texts.

- AR - measures the ability to discover rules and use these rules to solve reasoning problems and the ability to draw correct conclusions from different statements. The test AR consists of two subscales: inductive reasoning subscale (Reasoning A) and subscale of deductive reasoning (Reasoning B). Each of them contains 12 items.

The A-Reasoning Test contains two types of items: one containing strings of letters and another containing strings of images. The subject must identify the rules for string formation and decide, based on these rules, on the answer variant that allows its correct continuation.

The B Reasoning contains rules of deduction in such a way that the conclusion necessarily flows from certain premises.The subjects are presented with the premises, in the form of situations, and four conclusions, from which they must choose the one derived from previous statements (7).

d) Statistical processing

The quantitative analysis of the obtained results was carried out in the SPSS program version 23.

Some statistical programs, such as our SPSS version 23, produce "Sig" or "Sig(2-Tailed)" values as part of t-test results and p-value correlations. In the SPSS program, "Sig" or "Sig(2-Tailed)" is equivalent to the p-value and represents the significance of the difference in the means.

Results

Table I

Inter-group analysis of the dynamics of results in the MC initial test (Ti).

		Group Statistics									
	Groups	N	Mean	Std. Deviation	Std. Error Mean						
Calc_matemi	GE	15	8.067	2.7377	.7069						
	GC	32	6.813	3.1565	.5580						
		Independent Samples Test									
		Levene's Test for Equality of Variances		t-test for Equality of Means							
Indicator			F	Sig.	T	Df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower		Upper
Calc_matemi	Equal variances assumed		.467	.498	1.322	45	.193	1.2542	.9489	-6.570	3.1654
	Equal variances not assumed				1.393	31.381	.174	1.2542	.9006	-5.817	3.0900

Table II

Inter-group analysis of the dynamics of results in the MC final test (Tf).

Group Statistics										
		Groups	N	Mean	Std. Deviation	Std. Error Mean				
Calc_matemf		GE	15	14.200	1.0823	.2795				
		GC	32	8.594	2.8268	.4997				
Independent Samples Test										
Indicator		Levene's Test for Equality of Variances				t-test for Equality of Means				
		F	Sig.	T	Df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
Calc_matemf	Equal variances assumed	11.212	.002	7.395	45	.000	5.6063	.7581	4.0794	7.1331
	Equal variances not assumed			9.792	43.912	.000	5.6063	.5725	4.4523	6.7602

Table III

Inter-group analysis of the dynamics of the MR test results (Ti and Tf).

Group Statistics										
		Groups	N	Mean	Std. Deviation	Std. Error Mean				
Rat_matemi		GE	15	6.667	2.7430	.7082				
		GC	32	6.063	2.9505	.5216				
Rat_matemf		GE	15	14.933	2.7377	.7069				
		GC	32	8.125	2.7090	.4789				
Independent Samples Test										
Indicator		Levene's Test for Equality of Variances				t-test for Equality of Means				
		F	Sig.	t	Df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
Rat_matemi	Equal variances assumed	.119	.732	.669	45	.507	.6042	.9036	-1.2157	2.4240
	Equal variances not assumed			.687	29.399	.498	.6042	.8796	-1.1937	2.4020
Rat_matemf	Equal variances assumed	.010	.922	8.005	45	.000	6.8083	.8505	5.0953	8.5213
	Equal variances not assumed			7.974	27.211	.000	6.8083	.8538	5.0571	8.5596

Table IV

Inter-group analysis of the dynamics of the results in the TC test (Ti and Tf).

Group Statistics										
		Groups	N	Mean	Std. Deviation	Std. Error Mean				
Intel_texti		GE	15	6.333	1.7593	.4543				
		GC	32	6.938	3.1820	.5625				
Intel_txtf		GE	15	14.667	1.9518	.5040				
		GC	32	8.563	2.8391	.5019				
Independent Samples Test										
Indicator		Levene's Test for Equality of Variances				t-test for Equality of Means				
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
Intel_texti	Equal variances assumed	6.968	.011	-.685	45	.497	-.6042	.8816	-2.3798	1.1715
	Equal variances not assumed			-.836	43.578	.408	-.6042	.7230	-2.0617	.8534
Intel_txtf	Equal variances assumed	4.007	.051	7.515	45	.000	6.1042	.8123	4.4682	7.7401
	Equal variances not assumed			8.582	38.458	.000	6.1042	.7112	4.6649	7.5434

Table V

Inter-group analysis of the dynamics of the AR test results (Ti and Tf).

		Group Statistics				
		Groups	N	Mean	Std. Deviation	Std. Error Mean
Scor_rai	GE		15	11.267	2.0166	.5207
	GC		32	9.594	4.2870	.7578
Scor_raf	GE		15	16.200	2.5690	.6633
	GC		32	11.844	3.4371	.6076

		Independent Samples Test								
		Levene's Test for Equality of Variances				t-test for Equality of Means				
Indicator		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Scor_rai	Equal variances assumed	12.447	.001	1.433	45	.159	1.6729	1.1677	-6.790	4.0248
	Equal variances not assumed			1.819	44.981	.076	1.6729	.9195	-1.790	3.5248
Scor_raf	Equal variances assumed	1.618	.210	4.361	45	.000	4.3563	.9990	2.3442	6.3683
	Equal variances not assumed			4.843	35.927	.000	4.3563	.8995	2.5318	6.1807

Discussion

The results recorded by the students of the two groups of the experiment were analyzed dynamically, from Ti to Tf, for each assessment tool. We present below the results and the value of the t-test, the test used to interpret the value of the differences between groups. This test is used where there are two separate groups of participants, independent samples for which scores corresponding to certain variables are determined.

a) Inter-group analysis of the dynamics of results in the MC test

Tables I and II show the results of the t-test performed on the two independent samples in the case of the MC variable at Ti and Tf.

It was found that there were differences between the initial scores of the two groups (i.e. a higher average score for the experimental group), but the difference is not statistically significant (Sig. (2-tailed) = 0.193 > 0.05).

The Tf score in this test shows that between the experimental group and the control group there is a statistically significant difference of 5.60 points - Sig. (2-tailed) < 0.05. Levene's test is statistically significant, which is why we used the information on the last rows of the second table (Table II).

b) Inter-group analysis of the dynamics of the MR test results

Table III shows the results of the t-test performed on the two independent samples in the case of the MR variable at Ti and Tf.

There is a small difference in mean Ti scores (only 0.6 points) and this difference is not statistically significant (Sig. (2-tailed) = 0.507 > 0.05).

The Tf score highlights a difference between the average scores of the two groups of 6.8 (higher scores for students in the experimental group), a significant difference from a statistical point of view, since Sig. (2-tailed) < 0.05. We took the materiality threshold data from the table, for the

test for each variable we followed the last lines of the table, as the Levene test was not statistically significant in either situation (Sig. > 0.05).

c) Inter-group analysis of the dynamics of the results in the TC test

Table IV presents the results of the t-test performed on the two independent samples in the case of the variable of TC at Ti and Tf.

Analyzing the data for Ti, we found that the Levene test is statistically significant (Sig. = 0.011 < 0.05). There is a difference of 0.6 points between the mean scores of the students, but this is not statistically significant - Sig. (2-tailed) = 0.408 > 0.05.

The analysis of the data at Tf reveals that the Levene test is not statistically significant (Sig. = 0.051 > 0.05), consequently, we will take the data from the last row, from the table. Between the average score of the experimental group (14.66) and that of the control group (8.56) there is a fairly large difference (6.10 points), also significant from a statistical point of view.

d) Inter-group analysis of the dynamics of the AR test results

Table V shows the results of the t-test performed on the two independent samples in the case of the AR variable at Ti and Tf.

Levene's test for Ti scores is statistically significant (Sig. = 0.001 < 0.05). Although the mean scores recorded for analytical reasoning between the experimental group and the control group is 1.67, which is not statistically significant (Sig. (2-tailed) = 0.076 > 0.05).

Analysis of Tf scores reveals that Levene's test is not statistically significant. Average score for AR it is higher in the experimental group by 4.36 points, a difference that is significant from the point of view statistic.

Conclusions

1. Both for the experimental group and for the control group, statistically significant developments were recorded in all tested variables (mathematical calculation,

mathematical reasoning, understanding of texts, analytical reasoning), as a result of the entire educational process in which all participated students, during the school year.

2. There are differences between the initial scores for the variables analyzed in the two groups (higher scores in the experimental group), but these are not statistically significant.

3. The scores at the final assessment for the measured variants are higher in the experimental group, and the differences are statistically relevant in all situations.

4. The experimental group recorded superior results in the assessment tests as a result of practicing chess as an optional subject during the 2022-2023 school year: increasing the intelligence quotient, developing problem-solving skills.

5. Chess offers practical opportunities for making quick and correct decisions under time pressure, teaches students to think logically and efficiently, improves communication ability and the ability to identify patterns of thought and action.

6. We have found that playing chess helps students develop intellectually: the ability to discover rules and use these rules to solve reasoning problems; the ability to draw correct conclusions starting from different statements; the subject's ability to construct meaning and generate inferences; the ability to process acquired mathematical knowledge; the ability to identify mathematical relationships between the numbers in an ordered sequence and use these relationships to complete the sequence.

Conflicts of interest

We declare that there are no conflicts of interest.

Acknowledgments

The research capitalizes on partial results from the first author's doctoral thesis, ongoing at the National University of Science and Technology Politehnica Bucharest, Pitesti University Center.

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