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Original Article

Educational Optimization Of Students Through The Development Of Cognitive Skills By Learning The Game Of Chess

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Abstract

The research is aimed at primary school students and aims to highlight the benefits of playing chess at this age. By practicing the game of chess by students up to 10 years of age, the aim is to increase the degree of understanding of the rules of the game, develop the cognitive functions of the subjects materialized in the ability to make new decisions, problem solving and develop the speed of reaction/attention between stimulus and response. The experiment included a series of tests designed to identify and measure the subjects' cognitive parameters, non-verbal fluid intelligence and their own body perception. Through the conclusions drawn, the research confirms the initial hypothesis and provides a tool for optimizing chess activity at this age.

1. Introduction

Chess, located at the intersection of sport and science, is, from a competitive perspective, a sport that requires training and mental endurance, and from an analytical perspective, an exact science based on logic, studied in mathematics, combinatorics, graph theory, psychology and neuroscience, becoming in recent years a field of study in artificial intelligence – chess algorithms (Stockfish, AlphaZero) have revolutionized artificial intelligence and machine learning.

This duality makes chess unique in the sphere of intellectual activities and one of the most intensely studied fields.

A thousand-year-old sport, belonging to a long-extinct history, chess became known in India around 570 and later spread to the Arab peoples who popularized it

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in Europe. It underwent important adaptations and transformations regarding the names and rules, reaching around the 1800s the modern form that we still know today. The establishment in 1924 of the International Chess Federation (F.I.D.E.) marks the beginning period of modern chess dominated by prolific players such as Jose Raul Capablanca and Alexander Alekhine. (Kasparov, 2003)

In our country, the Romanian Chess Federation, founded in 1925, aims to "popularize, spread and develop the practice of chess throughout the country as a sporting, scientific-creative, educational, cultural and artistic element, promoting the spirit of harmony, fairness, tolerance and fair play." (Statute of the Chess Federation, 2025). An important goal of the Federation was the introduction of chess as an optional subject in schools, a fact achieved at the protocol level with the adoption of Declaration no. 50/2011 of the European Union and factually starting with the 2014 – 2015 school year, when chess becomes an optional subject in Romanian education under the name "Education through chess" (Nanu, Enoiu, Teriș, 2023).

Going beyond the primary concepts of scientific thinking, we learn that chess is deeply connected with notions of statistics, databases, representations, flowcharts, artificial intelligence, tools that today have significant applicability in the real world and in business, not just in the sports sphere. A topic of great interest is the development of chess programs and artificial intelligence, a field that has made huge progress in recent years. Thus, today, their purpose is to reduce the selection of possible moves to a minimum in order to shorten the calculation processes similar to those of the chess player to make them more efficient (Nanu, Coman, Bularca, Mesesan – Schmitz, Gotea, Atudorei, Turcu, Negrila, 2023).

A special place in the discussion about the functions of sport, along with education, is reserved for socialization. Sport is increasingly imposing itself as a mass phenomenon capable of fundamentally influencing the psyche and consciousness of people belonging to all social spheres, supported by its immense representation in all areas.

Currently, chess is one of the five most popular sports among people with health problems: 9% of the total number of people with disabilities who participate in physical culture and sports activities are chess players. (Mikhaylova, 2018) Long-term adaptive changes in psychophysiological parameters (development of attention, level of noise immunity, level of functional capacities of the nervous system, activity of neurovegetative regulation levels of heart rate at rest and in mental load tests) are associated with the influence of increased mental loads during chess play (Ryasantsev, 2009). For this reason, the use of chess as a training model could become one of the innovative approaches to solving the problem of social adaptation and rehabilitation of people with disabilities, in line with the priority orientation of state policies in the field of education.

Also, chess is a sport that allows the inclusion of visually impaired people in competitions, according to Article 12 of the F.I.D.E. Regulations. *Guidelines on Treatment of Disabled Chess Players,* who have the right to benefit from adequate conditions consisting of special assistance and logistics.

Multiple researches claim that chess develops, among other things, general intelligence, the ability to concentrate, self-control, analytical skills and reading skills. (De Groot, 1977; Binet, 1903; Ceobanu, 2010; Cosmovici, 2005; Gardner, 2006; Gobet, & Campitelli, 2005). Going with the analysis to a deeper level, one comes to the conclusion that chess training can offer two types of benefits:

- ✓ "primary benefits," such as improved concentration, awareness that learning and progress in a particular field is achieved through study and interest in the activity, fostering resilience;
- ✓ "high-level benefits," such as increased intelligence, creativity, and critical thinking.

2. Material and methods

The purpose of the research is to establish the degree of understanding and integration by students of chess rules and strategies.

Objective of the search: Highlighting the benefits of practicing chess, materialized in the development and improvement of essential cognitive functions that influence learning, decision-making, and the ability to solve complex problems.

Hypothesis. In the research, we started from the hypothesis that primary school students who practice chess as an optional subject during class hours will develop superior cognitive skills, superior body perception and good spatial-visual orientation.

Research methods. The research aims to test a batch of third grade students aged between 9 and 10 years old from a general school in Brasov.

The research was carried out between September 2024 and June 2025 and is based on chess technical training of the basics, such as: exercises of knowledge and placement on the board of chess pieces: king, queen, rook, bishop, knight, pawn, exercises of knowledge of lines, columns and diagonals, exercises of positioning each piece on the chessboard, of their movement and capture, elements of distance, neighborhood, separation, closing, opening, notions of chess and checkmate. Also, during the training hours, appropriate and adapted physical exercises for children practicing the game of chess were included, exercises aimed at developing coordination skills, joint flexibility, mobility, as well as correcting the procrastination on the chessboard. They were performed at the end of the class, and their duration varied between 5-15 minutes, depending on the degree of difficulty, as well as the possibility of their effective integration into the training, depending on the chess topics addressed.

- *Toulouse Pieron Dams Test*

Through this test, the aim is to identify the cognitive parameters: measuring attention – ability to concentrate, ability to understand and memorize, spirit of observation, efficiency of using spatial elements.

Working methodology:

23 rows of 20 squares are given with a bar placed either in the corners or on the sides of the square; The theme is to find and bar the 4 squares given as a pattern, working simultaneously. The mistake that the subject notices, can be corrected by

circling the square; The working time granted was 7 minutes.

To determine the quantitative aspect of attention, the sum (total) of the correctly crossed out marks is taken into account, as follows: Quantity = Correct total, for the assessment of quality, the formula is applied: Quality = Correct Total - Wrong Total/Correct Total + Total Obtained

- *Raven Progressive Matrix*

Test used to assess non-verbal fluid intelligence, consisting of a series of incomplete images (matrices), from which the subject must identify the piece that correctly completes the model. The subject must choose, from several options, the piece that completes the matrix according to a logical model, the test being progressive, the difficulty increasing as the subject progresses. Used as standard for assessing visual-spatial abilities and abstract intelligence, it indicates individuals' ability to recognize patterns, reason logically, and solve problems, but it does not assess emotional or creative intelligence.

- *Good Enough Test - Body Diagram Assessment*

Defining this test, we can say that the Good Enough test represents "the image that each individual has of their own body, through which they evaluate the relationship between body segments and the environment" (Șunei, Nagel, 2021).

The body schema is considered the image that each individual has of their own body in relation to the body segments and the environment. The body schema is a fundamental element of psychomotor behaviors, along with laterality and spatio-temporal orientation (Albu & al., 2006).

Given the fact that the formation of the body schema is a process that takes place in several stages, primary school children are influenced in this direction through physical exercises as follows: the formation of the temporal coordinates of movements and their memory, the development of static and dynamic balance, the development of motor intelligence. The calculation of the indices is calculated according to the formula: IQ = VM (mental age)/VC (child age) x 100, the score obtained being a relevant indicator, where a level obtained between 90-118 defines an average standard, and above 120, a superior intelligence.

3. Results and Discussions

- *Raven Progressive Matrix (IQ) Test*

The descriptive statistics for the Raven Progressive Matrices are presented in table number 1 (IQ coefficient)

Table 1. *Initial and final test index values Raven Matrix*

	Mean	Standard deviation	Minimum	Maximum	Median	Variance
IT (Val1)	90	7.80	70	99	91	60.84
TF (Val2)	100.25	7.52	75	108	101	56.51

Analyzing the average value of the experimental data, we find that it recorded a value of 90 at the initial test, while at the final test it increased to 100.25. These values confirm the progress made by the experimental group in the case of final testing.

The standard deviation values are approximately similar in the two initial and final tests, with a positive trend in the case of the final one. The standard deviation at the final test expresses a slightly reduced dispersion, indicating a minor compression of the interindividual variation.

The minimum values recorded in the case of the final test have an average of 70, while the final test recorded higher values reaching the index of 75. The maximum values also progress in the final test, 108, compared to the value of 99 recorded in the initial test (Table 1).

Figure 1 shows a clear increase in the mean, median and maximum values after the test, while the standard deviation and the minimum remain relatively close between the two moments.

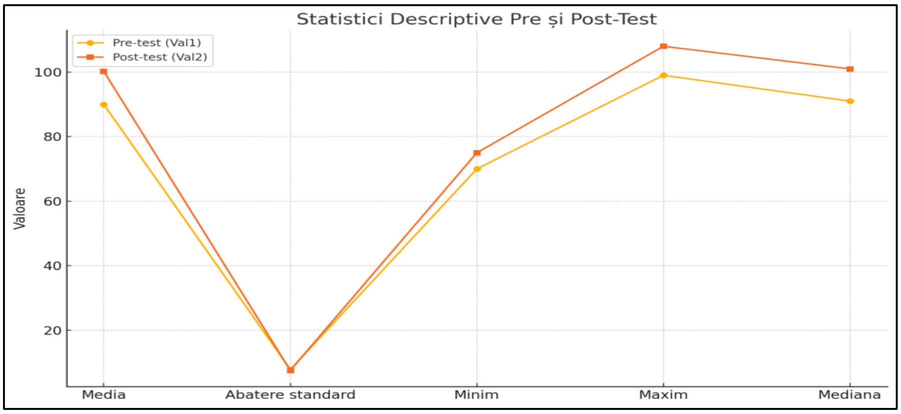

Figure 1. *Distribution of indices initial testing and final testing Raven Matrix*

Analyzing the distribution of the indices in the case of the two tests, initial and final for the Raven descriptive matrix, we find the following:

- The increase in the average on the final test suggests an overall improvement in performance and a better reaction to the second evaluation.
- Minimum and maximum values – both tests show a wide range of scores, but the final test values reach high levels.
- The variability between subjects is almost constant between the two tests, which means that the differences are evenly distributed. (7.80 vs. 7.52)

The variance at baseline testing is slightly higher, suggesting that the initial scores were more dispersed.

- *Toulouse Pieron Dams Test*

Analyzing the very small Shapiro-Wilk coefficients (and $p < 0.001$) we find that we obtain a substantial deviation from normal for both measurements.

The choice of a non-parametric test for paired samples is therefore methodologically justified (Table 2).

Table 2. *Toulouse Pieron Distribution Normality Test*

	Shapiro-Wilk		
	Mean	Df	p
Toulouse Pieron - Initial	,664	20	,000
Toulouse Pieron - Final	,512	20	,000

Descriptive statistics for even samples

The average performance increased by 0.137 points (≈ 17% compared to the initial level).

The standard deviation decreased more than threefold (0.284 → 0.088), suggesting a convergence of scores towards higher values after intervention (Table 3).

Table 3. *Statistics for paired samples Toulouse Pieron*

		Mean	N	Standard deviation
Pair 1	Toulouse Pieron - Initial	,8080	20	,28415
	Toulouse Pieron - Final	,9445	20	,08846

Based on the experimental results recorded during the two tests, we can find the following:

- The development of attention/reaction speed can be observed by increasing the median and decreasing variability, which shows that the subjects progressed homogeneously.
- Since the experiment materialized through an intervention (chess training, specific training), the results suggest that it has a clear impact on focusing skills and processing speed.
- The convergence of scores from SD = 0.284 to SD = 0.088 also indicates an equalization of performance between subjects, reducing the initial gaps (Table 3).
- The gray area in figure number 2 indicates the difference between the two values, TI (Val1) and TF (Val 2), highlighting how close or different they are. Subjects with large differences (e.g., topic 6 and topic 16) stand out through a wider gray area.

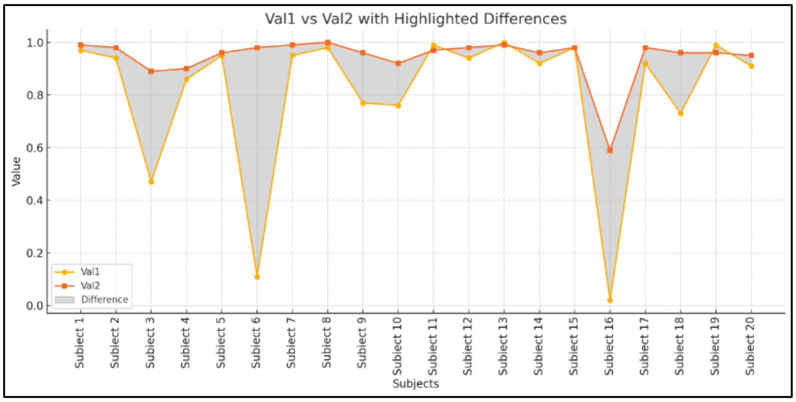

Figure 2. *Toulouse Pieron initial and final testing chart and the difference between them*

- *Goodenough Test (IQ)*

At the initial evaluation, the subjects obtained an average score of 97.38 IQ points, accompanied by a standard deviation of 18.61 points – a value that indicates a moderate dispersion of the visual-constructive level among the participants.

After the intervention, at the final test, the average rose to 106.25 IQ points, and the standard deviation increased slightly to 20.60 points, a sign that, although the overall performance improved by about nine points, the inter-individual variability remained pronounced (Table 4).

Table 4. *Statistics for Paired Samples at Goodenough Testing*

		Mean	N	Standard deviation
Pair 1	Goodenough (IQ) - Initial	97,380	20	18,6105
	Goodenough (IQ) - Final	106,250	20	20,6005

Figure 3 shows the following:

The 10-year-old girls had the highest average progress: +26.4%, significantly higher than the rest of the groups, suggesting that the intervention was particularly effective in this sample.

9-year-old boys had slightly higher growth than girls of the same age (+9.4% vs. +7.2%).

10-year-old boys recorded a moderate increase (+8.1%), but well below the level of girls of the same age.

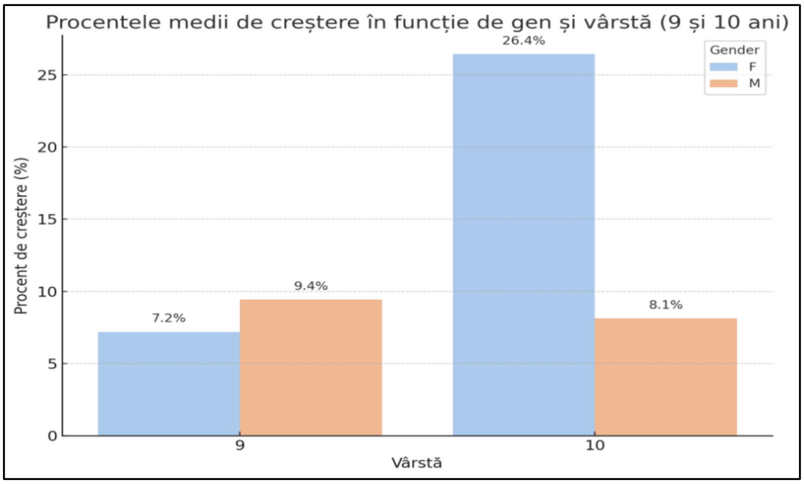

Figure 3. *Average growth percentages by age and gender in the Goodenough Test*

Analyzing the results for the T-test (Table 5) in the case of paired samples, we find that the results are significant p = 0.07, which implies that the intervention produced a robust improvement in the estimated IQ score. The validity of the experimental data is also confirmed by the average between the two tests 8.8700, which means a substantial progress of the subjects in the case of the final test.

Table 5. *Test for Paired Samples at Goodenough Testing*

		Differences between pairs			
		Mean	t	Df	p
Pair 1	Goodenough (IQ) - Initial - Goodenough (IQ) - Final	-8,8700	-3,032	19	,007

Discussions

By analyzing the results obtained in the 3 control tests, we can see the efficiency of the implemented experimental program, both from a statistical perspective and from a practical point of view, generating significant and consistent progress in terms of fluid intelligence and superior capacities for abstract reasoning and solving new problems (Figure 3).

In the group of 9–10-year-old students, the IQ score estimated by the Goodenough Test increased significantly, with a moderate-high effect. This result completes the picture of the observed improvements in the parameters of attention (Toulouse-Pieron), fluid intelligence (Raven Matrix), indicating that the educational program has an impact not only on cognitive processing functions, but also on spatial-visual development.

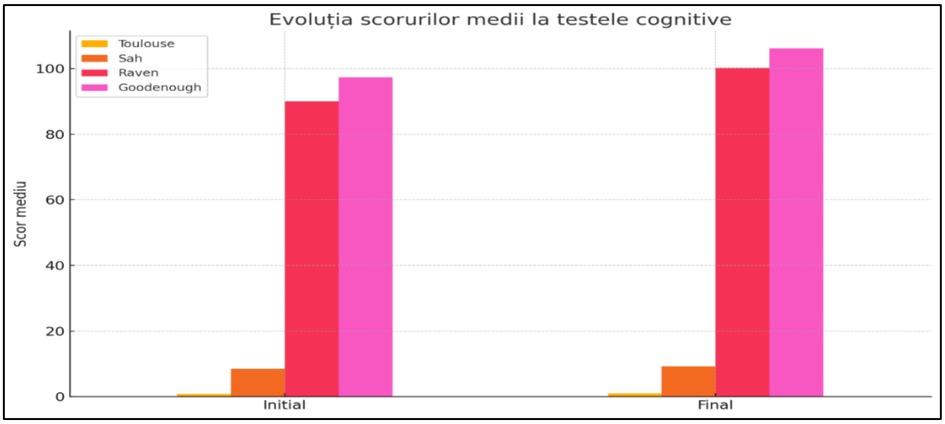

Figure 4. *Centralizing graph - Evolution of average scores in the tests carried out in the preliminary research*

The figure above compares the initial and final mean values obtained by the participants in the four psychometric instruments used in the experimental program.

4. Conclusions

- Toulouse Pieron - visible growth, indicating the development of attention and reaction speed.
- Raven Matrix (IQ) - average increase of 10 IQ points, highlighting the development of fluid intelligence. The most pronounced progress is visible in the Raven test, where the average score increased significantly (from approx. 90 to 100).
- Goodenough test (IQ) – also shows a significant average increase, which suggests an improvement in perceptual-visual abilities.
- In addition to the three tests presented and described in the scientific experiment, the impact of the research was also verified by introducing a fourth test. Chess Test – this fourth indicator was constantly evaluated throughout the scientific experiment through the subjects' ability to correctly identify and recognize all the pieces on the chessboard, as well as the degree of mastery of theoretical and practical chess notions.

References

1. ALBU, C., & NAGEL, I. (2006). *Psychomotricity: Theoretical and methodological landmarks*. Iași: Polirom.
2. BINET, A. (1903). *The Experimental Study of Intelligence*. Paris: Schleicher.
3. CEOBANU, C. (2010). *Educational psychology*. Iași: Polirom.
4. COSMOVICI, A. (2005). *General Psychology*. Iași: Polirom.
5. DE GROOT, A. (1977). *Thought and choice in chess*. The Hague: Mouton Publishers.
6. GARDNER, H. (2006). *Intelligence reframed: Multiple intelligences for the 21st century*. New York: Basic Books.

7. GOBET, F., & CAMPITELLI, G. (2005). The role of domain-specific practice, handedness and starting age in chess. *Developmental Psychology, 41*(4), 531–539.
8. KASPAROV, G. (2003). *My great predecessors* (Vol. 1). London: Everyman Chess.
9. MIKHAYLOVA, S. (2018). Adaptive changes of psychophysiological parameters during chess play. *Journal of Physical Education and Sport, 18*(2), 894–900.
10. NANU, C. C., COMAN, C., BULARCA, M. C., MESEȘAN-SCHMITZ, L., GOTEA, M., ATUDOREI, I., ... & NEGRILĂ, I. (2023). The role of chess in the development of children: Parents' perspectives. *Frontiers in Psychology, 14*, 1210917.
11. NANU, C., ENOIU, R. S., & TERIȘ, S. (2023). Study regarding the effectiveness of chess in children. *Gymnasium, 24*(1), 101–116.
12. RYASANTSEV, A. (2009). Psychophysiological adaptation in chess players. *Human Physiology, 35*(5), 587–593.
13. STATUTE OF THE CHESS FEDERATION. (2025). Retrieved from https://frsah.ro/statut/
14. ȘUNEI, A., & NAGEL, I. (2021). *Body schema and child development*. Bucharest: Didactic and Pedagogical Publishing House.