Chapter #15

ENHANCING VERBAL REASONING THROUGH CHESS TRAINING

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ABSTRACT
Verbal reasoning is the ability of a person to understand the meaning of verbal information, enabling the individual to further process the verbal information placed before them. This study assessed the outcome of 1-year chess intervention on the verbal reasoning of children. A pretest–posttest with control group design was utilized, with 70 children in the experimental group (mean age 11.05 years; SD 2.49) and 81 children in the control group (mean age 11.10 years; SD 2.37). Children of both genders, studying in two governments and two private schools (grades 3–9), formed the sample. The experimental group received weekly chess training for an hour, while the control group participated in extracurricular activities. Verbal reasoning was measured by Binet–Kamat Test of Intelligence. The chess intervention included Winning Moves Chess Learning Curriculum, video lectures, demonstration board, on-the-board playing, chess workbooks, and studying tactical and end game positions by case studies. Analysis of covariance revealed significant gains in verbal reasoning in the experimental group compared to the control group, indicating a link between chess training and verbal reasoning. Strengthening verbal reasoning skills leads to significant outcome in the child's overall development and academic performance.

Keywords: chess training, cognitive development, schoolchildren, verbal reasoning.

1. INTRODUCTION

Chess is a classic game of strategy that develops various cognitive processes. It is widely believed to increase "mental muscle" (Kitsis, 2006), raise intelligence quotient (IQ), help prevent Alzheimer's, exercise both sides of the brain, increase creativity, and improve memory (Friedland et al., 2001; Margulies, 1991). Many schools all over the world encourage their students to play chess to enhance their academic performance. Playing chess systematically raises students' IQ and exam scores (Dullea, 1982; Ferguson, 2000; Palm, 1990), strengthens math ability besides reading and language skills (Ferguson, 2000; Liptrap, 1998; Margulies, 1991), and improves academic performance (Joseph, Easvaradoss, & Solomon, 2016).

Why does chess have this impact? What cognitive processes are involved in a child when they begin to learn and play chess? Strategy, planning, judgment, calculation, and understanding patterns and techniques are all involved and required of a chess player. It involves the child's thinking processes, right from the ability to perceive clearly the various pieces of chess and possible threats and outcomes of each move; from the ability to play every move in line with the overall picture to the particular structure they want to achieve; from the ability to evaluate precisely the trading of pieces to the ultimate goal of checkmating the King.

1.1. Verbal comprehension and reasoning

Verbal comprehension is the ability to understand spoken language (McDuffie, 2013). One can think about verbal reasoning as spanning a dimension from understanding words to sentences to units of text to multiple texts and finally to whole systems of discourse (Burton, Welsh, Kostin, & van Essen, 2009). The concept of size of units of meaning is especially important in the discussion of expertise, where the ability to deal with complex problems is related to the ability to organize one's background knowledge into larger meaningful chunks. The ability to chunk relieves the constraints of working memory that can prevent one from attending to a complicated problem as a whole. Discussions of expertise also emphasize acquiring an extensive knowledge base.

The ability to gather, examine, and understand information in the form of words and languages is called verbal reasoning. It entails reading, writing, speaking, and listening and forms a vital part of a formal education. Verbal reasoning is one of the four basic cognitive skills that are essential to communicate effectively with people around us, reach conclusions, and make decisions based on the information accessible. Any learning process essentially involves verbal reasoning through word-based concept formation. It encompasses the collective ability of a person to understand the meaning of certain information in whatever forms it is presented, enabling his or her thought processes subsequently to learn the given information. It is the process of gathering information; analyzing, thinking, and evaluating it to form ideas, beliefs, and assumptions; and developing knowledge on the particular subject. While most children develop verbal reasoning right from 3 to 4 years of age, occasionally they fail to do so and require the assistance of professionals to help them attain these skills. Most often, the importance of verbal reasoning skills is undermined on the supposition that tasks like reading, writing, and speaking come naturally to school-going children. However, developing verbal intelligence and reasoning skills plays an important part in a child's overall development. Children begin to answer the basic who, why, what questions right from a tender age and they also question things around them, seeking answers and expanding their knowledge base. Verbal reasoning is an imperative tool for academic learning and to thrive in one's professional life.

2. BACKGROUND

Early research on chess instruction has tended to provide empirical support for the beneficial effects of chess training on performance on cognitive tasks (Christiaen & Verholfstadt, 1978; Frank & D'Hondt, 1979; Horgan, 1987; Smith & Cage, 2000). For example, in an experimental study, Frank and D'Hondt (1979) found that an experimental group of learners receiving chess instruction scored better on both numerical and verbal aptitude tests than did a control group of learners not receiving chess instruction. These findings lend credence to the application of chess instruction to students with cognitive challenges. A review of studies by Meyers (2011) carried out in many locations across the United States and Canada showed that playing chess resulted in increased scores on standardized tests, for both reading and mathematics. One of them was on a large-scale chess program in New York City, which involved more than 100 schools and 3,000 children. Results showed higher classroom grades in both English and mathematics for children involved in chess. The review also included studies in Houston, Texas and Bradford, Pennsylvania and showed that playing chess led to higher scores on the Watson Glaser Critical Thinking Appraisal (Watson & Glaser, 1952) and the Torrance Tests of Creative Thinking (Torrance, 1966).

Thus, chess instruction may be a productive intervention for students at risk for academic failure. Research on chess instruction for students at risk may likely provide both regular and special educators with practical suggestions on how to develop higher order cognitive skills and to improve scholastic achievement levels among learners. Furthermore, Storey (2000) suggested that chess instruction could also benefit children with disabilities, even though only anecdotal evidence is available for the effect of chess play on students with disabilities (Remsen, 1998; Wojcio, 1995).

Unterrainer, Kaller, Halsband, and Rahm (2006) compared the preplanning, accuracy, and movement execution time of chess and nonchess players. Additionally, fluid intelligence, verbal working memory, and visuospatial working memory were also measured. The study included 25 chess players selected from two chess clubs and 25 nonchess players who had no experience at all in playing chess. The results of the study indicated that chess players showcased better planning abilities than nonchess players. However, they required longer movement execution and planning times. There were no differences found between both groups in fluid intelligence, verbal and visuospatial working memories.

Joseph, Easvaradoss, Abraham, and Jain (2018) examined the outcome of 1-year systematic chess training on the verbal reasoning of children. A pretest–posttest with control group design was used, with 70 children in the experimental group (mean age = 11.05 years; SD = 2.49) and 81 children in the control group (mean age = 11.10 years; SD = 2.37). The sample consisted of children studying in two government schools and two private schools (grades 3–9), which included both the genders. The experimental group underwent weekly chess training for an hour, while the control group was involved in other games offered in school such as cricket, football, hockey, etc. Verbal reasoning was measured by Binet–Kamat Test of Intelligence. The chess training intervention included Winning Moves Chess Learning Curriculum (Joseph, 2008), video lectures, demonstration board learning, on-the-board playing and training, chess exercise through workbooks, and studying tactical and end game positions by case studies. The games were also recorded and analyzed by writing score sheets. Analysis of covariance (ANCOVA) revealed significant gains in verbal reasoning in the experimental group compared to the control group. There was also significant improvement in overall intelligence, but no significant interaction effects were seen between intervention and gender and type of school on verbal reasoning. The study establishes a link between chess training and verbal reasoning and indicates that strengthening verbal intelligence and reasoning skills leads to important outcomes in the child's overall development and academic performance.

ElDaou and El-Shamieh (2015) investigated the effects of chess playing on concentration skills, period of concentration, and language listening skills in students diagnosed with Attention Deficit Hyperactivity Disorder (ADHD). The study consisted of 14 students aged between 11 and 13 years who were selected from two inclusive schools and the participants were trained in chess twice a week. The results of the study indicated that chess playing improves concentration skills, period of concentration, and language listening scores.

3. OBJECTIVE

While a number of studies have established that chess learning clearly improves cognitive functioning and academic performance, its impact on verbal reasoning is yet to be ascertained. It is likely that an increase in verbal reasoning is one of the basic factors

that supports these gains (Joseph et al., 2018). Hence a directional hypothesis was formulated. However, very few studies appear to have focused on the role of chess training in strengthening verbal reasoning.

It is hypothesized that systematic chess training would significantly increase verbal reasoning in children. The objective of the study was to assess the impact of weekly chess training on the verbal reasoning of school-going children.

4. RESEARCH DESIGN

This research study used an experimental design to study the impact of training in chess on the cognitive functioning of children. The Pretest–Posttest Control Group Design was utilized (Edwards, 1985; Kerlinger, 1973). The research design involved two groups of children: an experimental group and a control group. The experimental group consisted of children who participated in the 1-year Chess Training Intervention, while the control group was involved in the extracurricular activities offered by the school such as sports (football, cricket, tennikoit), music, arts and crafts during the same period.

5. METHODOLOGY

5.1. Sample

The sample consisted of 70 children in the experimental group (mean age 11.05 years; SD 2.49) and 81 children in the control group (mean age 11.10 years; SD 2.37). The experimental group consisted of 27 girls and 43 boys and the control group consisted of 29 girls and 52 boys. Four schools were selected, two government schools and two private schools, using convenience sampling. In each school, children were selected by random sampling. The sample that was selected had children falling into two age categories: 6–11 years and 12–16 years.

5.2. Inclusion criteria

The sample was recruited based on the following inclusion criteria:

- Children who are studying in schools
- Both genders
- Age range between 6 and 16 years
- Consent and commitment to a 1-year chess training program

5.3. Selection of sample

The steps followed in selecting the sample are as follows:

1. Schools were identified and permission was obtained. Contracts were signed with the school to carry out the study.
2. The children were randomly selected based on the inclusion criteria.
3. Informed consent was obtained from the parents and the children.
4. Random sampling within each school was used to form the experimental and control groups.
5. The following procedure was used to select students from each category:
    - Name list along with the date of birth of children was collected from the school.
    - Requirement analysis was made for each school.

- According to the number of students available in each category, using the random number selection method, the students were initially identified.
- Consent was taken from the parents of all of the selected students. Some students were dropped as their parents did not give their consent.
- IQ test (Binet–Kamat Intelligence Test) was done for all students. Based on the IQ scores, children with identical IQ scores were paired, taking into consideration gender and age.
- The children were then randomly assigned to two groups having equal mean of the IQ.
- Further, the head of the school assigned the two groups randomly into experimental and control group, by using the Lot system.
- Some of the students who fell into the experimental group opted out stating unwillingness to undergo regular chess training.

5.4. Dropout analysis

The research design envisaged 200 children with 100 students in control and 100 students in experimental groups. To ensure that the final numbers are maintained, 30 more children were selected; 31 students dropped out of the sample due to the following reasons:

- 7 children, who had earlier given consent, and were selected to be in the experimental group, dropped out because they were not interested in learning chess.
- 19 students from the government school left before the second assessment could be done, due to various reasons. One of the major reasons was that their homes were flooded due to a cyclone, and therefore they had to shift to other regions.
- 5 from private schools also left the school before the 2nd assessment was done. This resulted in number variations in different assessments.

6. OPERATIONAL DEFINITION

Chess Intervention: The chess intervention consisted of standardized weekly training sessions that lasted for 1 hour, during school hours, over a period of 1 year. Systematic training was provided following the Chess Training Curriculum.

Verbal Reasoning: The Verbal Reasoning score measures verbal knowledge and understanding obtained from the school and home learning environment and reflects the ability to apply verbal skills to new situations (Kamat, 1967).

7. TOOLS

Verbal reasoning was assessed using the Binet–Kamat Test of Intelligence. The Stanford revision of the test was adapted as the Binet–Kamat Test of Intelligence to suit the Indian children. The present version consists of various verbal and performance tests that can be administered to children and adults from ages 3 to 22 years. Validity of the test shows that when a fourfold table was drawn up and the correlation of the pluses and minuses of each test with mental age as obtained by the whole scale was found, the correlation coefficients of the tests were generally higher than 0.70. Correlations between IQ (as determined by the scale) and the teacher's estimates were found to be nearly 0.50, which is fairly high considering the variability of the teacher's estimates.

8. CHESS INTERVENTION

The chess intervention consisted of standardized weekly training sessions that lasted for 1 hour, during school hours, over a period of 1 year. Clustering technique was used to form the training groups. Chess training was adapted to the level of the child and the speed with which they grasped the concepts. Advanced concepts were taught if the child played well.

8.1. Grouping/Clustering

The children in the experimental group were grouped or clustered, according to their age, class, and playing strength—dynamically throughout the 1-year period. Regular assessments were made to ensure that the children were assigned in the right groups. In each school, there were at least 3–4 groups and equal number of chess trainers. All children were taught chess, beginning from the basics, as per the curriculum.

8.2. Curriculum

The Chess Training curriculum was developed by the research scholar who is a Candidate Master and also India's first FIDE Trainer to be certified by the World Chess Federation. This curriculum was presented and accepted in the London Chess Conference in December 2013, in the presence of many experts and current researchers involved in similar studies across the world. The curriculum for each quarter was as follows.

8.2.1. Chess Training Intervention

Usually the time allotted was 60 minutes per session for chess training. Half the time (about 30 minutes) was used for teaching by one of the following methods:

1. DVD lessons
2. Using Demonstration Board
3. Chess Workbooks
4. Working with Chess Software

The other half of the time was used for on-the-board chess training, playing games with one another, recording the games with score sheet writing, playing tournament games among themselves, solving problems on the board, learning end game techniques on the board, and solving tactical chess problems on the board.

9. IMPLEMENTATION OF THE MAIN STUDY

9.1. Ethical committee

An Ethical Committee comprising the Task Force of the Cognitive Science Research Initiative, Department of Science and Technology, Government of India, approved the cognitive assessments to study the impact of chess training on the Comprehensive Cognitive Development of children. Further, the Doctoral Committee endorsed the various measuring tools to be used for cognitive assessments.

9.2. Selection and contract with schools, and informed consent of students/parents

This study was carried out in the city of Chennai. There are about 1,500 schools in Chennai alone. These schools have different curriculums. Many school authorities were contacted and the content and scope of the study, which is a part of the Department of Science and Technology project, was explained to them. Finally, four schools were selected for this study out of which two were government schools and two were private schools.

Two schools were coeducation schools, out of which one had coeducation till the 5th grade. The other two schools were for boys only. The private schools had Matriculation syllabus and the government schools were following the Samacheer Education System.

A contract was signed with the school to conduct the study primarily to ensure that the school was committed to support the study. In addition to the contract, consent was also taken from the selected students and their parents toward their willingness to participate in the study. Students who had a low IQ (IQ score less than 80) were excluded from the study.

Pre-assessments were carried out by certified psychologists using the Binet–Kamat Intelligence Test. Psychologists were blind as to whether the child belonged to the experimental or the control group. The time taken for each IQ assessments (Binet–Kamat Intelligence Test) ranged from 60 to 90 minutes. Other relevant information was collected using a personal data sheet.

Chess Training Intervention was started and was carried out by professional trainers over a period of 1 year. Each chess session duration was about 1 hour and about 25–30 chess learning sessions were administered for each student of the experimental group, while the students in the control group were actively involved in other activities such as football, cricket, tennikoit, music, arts, and crafts.

Post-assessments were done at the end of 12 months using the same tests.

9.3. Statistical analysis of data

- Independent t-test was used to establish the equivalence of means prior to the chess training and to test the significance of difference between the means following the chess training.
- ANCOVA was used to compare the experimental and control groups on the dependent variables.
- Cohen's d was used to assess the effect size.

10. RESULTS

Normality of the distribution was tested using Binet–Kamat Intelligence Test during the pre-assessment. The scores were found to be normally distributed. The analysis was carried out using SPSS to establish the significance of the difference between the experimental and control groups on the verbal reasoning scores following intervention, holding the pre-intervention scores as covariate. The results of the current study are presented, followed by the discussion for each finding.

10.1. Impact of chess intervention on verbal reasoning

Table 1.
Descriptive statistics of verbal reasoning.

Variable	Assessment	Experimental Group (N = 70) Mean(SD)	Control Group (N = 81) Mean(SD)
Verbal Reasoning	**Pre**	2.80 (3.767)	2.59 (3.471)
	Post	5.63 (4.985)	3.68 (3.748)

Table 2.
ANCOVA between intervention group and control group on verbal reasoning at postintervention.

Sources of Variance	Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	1252.293	2	626.147	53.615	0.000
Intercept	658.081	1	658.081	56.35	0.000
Preverbal Reasoning	1109.575	1	1109.575	95.01	0.000
Exp Con	120.591	1	120.591	10.326	0.002**
Error	1728.422	148	11.679		
Total	6152	151			
Corrected Total	2980.715	150			

** $p<0.01$

Table 2 indicates that there was a significant effect of intervention on verbal reasoning at post-intervention ($p<0.01$). Table 1 shows that the mean verbal reasoning increased in the experimental group from 2.80 to 5.63 following intervention, compared to the control group which increased from 2.59 to 3.68.

10.2. Analysis of verbal reasoning—Gaussian normal distribution curve

The probability density function (PDF) and the cumulative distribution function (CDF) for pre- and post-experimental (group which is undergoing chess) verbal reasoning are plotted in Figures 1 and 2, respectively. The PDF plot in Figure 2 (left) clearly shows that pre- and post-experimental verbal reasoning distribution curves are separated much better than in Figure 1 (right) and a higher mean is observed for post-experimental verbal reasoning. This indicates a better improvement in those who underwent chess training (experimental group) in the verbal reasoning. However, PDF plot in Figure 1 (right) clearly

shows that pre- and post-verbal reasoning for control group overlaps very close to each other as compared to Figure 1 (left). This indicates that there is not much improvement in verbal reasoning for control group as compared to the experimental group who had undergone chess training. The CDF plot for pre- and post-verbal reasoning for control group is shown in Figure 2.

Figure 1.
PDF plot of pre- and postexperimental (left) and control group (right) for verbal reasoning.

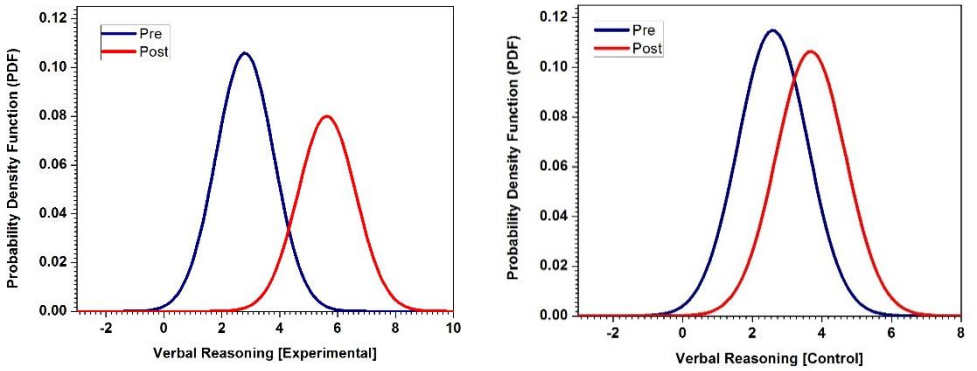
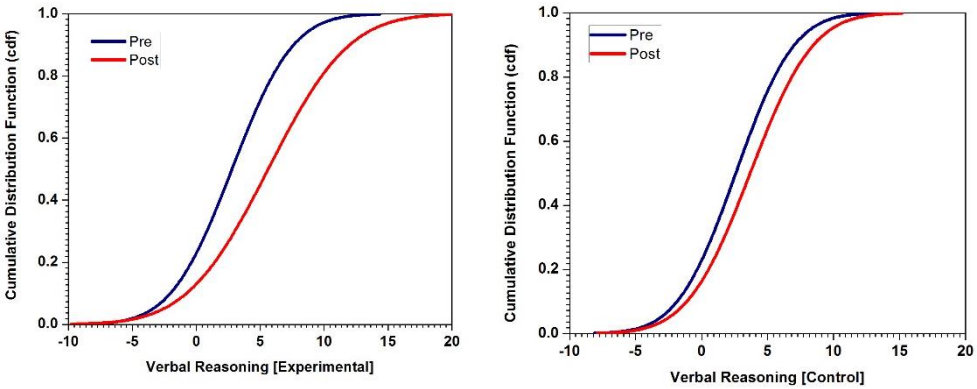


Figure 2.
CDF plot of pre- and post experimental (left) and control group (right) for verbal reasoning.



11. DISCUSSION

Playing chess develops cognitive skills like focusing, visualizing, thinking ahead, weighing options, analyzing concretely, thinking abstractly, planning, and juggling multiple considerations simultaneously. Over time, it is believed that chess helps develop patience and thoughtfulness. However, what is heartening and surprising is that these cognitive changes that have occurred have translated to quantifiable scores on a psychometric test.

While the impact of chess on cognitive functions and academic performance has been widely researched and clearly established (Ferguson, 2000; Palm, 1990; Smith & Cage, 2000; Trinchero, 2013), its influence in strengthening verbal abilities in general and verbal reasoning in specific remains un-researched to a great extent.

The ANCOVA results in Table 2 reflect significant gains in the verbal reasoning skills of the children in the intervention group compared to the control group. This finding is noteworthy because chess playing has clearly shown a significant increase ($p < 0.05$) in verbal reasoning scores. The tasks on which changes were measured were the Absurdities subtest and the Problem Question subtest. These findings were corroborated in another study by Joseph et al. (2018) who found significant gains in verbal reasoning in the intervention group compared to the control group. They also found a significant improvement in overall intelligence but no significant interaction effects were seen between intervention and gender and type of school on verbal reasoning.

The chess intervention that was carried out had a strong reasoning component where the child thinks through and reasons out the best possible moves given a certain playing position. Further, they were trained to record notations of their games and discuss and analyze their moves from their score sheets. The chess notation is a two-dimensional learning strategy where they record the movement of pieces, noting the columns and the rows. Further, while analyzing a position, a chess player thinks using the notations by verbalizing it subvocally. These activities sharpen their abilities and strengthen their ability to think clearly and logically, resulting in an enhancement of their verbal reasoning ability. These outcomes are likely to occur in chess interventions that actively incorporate a methodology where the child/player transcribes the movement of pieces into a language (chess notations).

The present study establishes a link between chess training and verbal reasoning. This study indicates that strengthening verbal intelligence and reasoning skills leads to important outcomes in the child's overall development and academic performance. Joseph et al. (2016) in their study measuring academic performance following chess training have reported increases in English and other subjects. The improved English scores could probably reflect a strengthening of the underlying augmented verbal reasoning skills. It is likely that chess training has an impact on not merely verbal reasoning but verbal ability such as language, reading, comprehension, and so on. The children in the Ferguson (1998) study demonstrated an increase in their reading scores.

11.1. Effect size

Table 3.
Cohen's d—effect sizes of the variable, which were found to have significant gains after chess training intervention.

Variable	N1	N2	μ_1	μ_2	σ_1	σ_2	Cohen's d	Effect Size
Verbal Reasoning	70	81	5.63	3.68	4.98	3.74	0.44217	Medium

Cohen's d: Effect sizes showing the difference between the means divided by the pooled standard deviation are given in Table 3. The effect size of the variable, which was found to have significant gains after chess training intervention, was analyzed using Cohen's d, which is calculated as the difference between the means, divided by the pooled standard deviation. It is found that Verbal Reasoning had medium effect sizes.

11.2. Impact of chess intervention with reference to age on verbal reasoning

Table 4.
ANCOVA between intervention group and age category on verbal reasoning at postintervention.
Tests of Between-Subject Effects.

Dependent Variable: Post-Verbal Reasoning

Age Category	Sources of Variance	Sum of Squares	df	Mean Square	F	Sig.
6–11	Corrected Model	344.519	2	172.259	36.154	0.000
	Intercept	105.675	1	105.675	22.179	0.000
	Pre-Verbal Reasoning	330.516	1	330.516	69.369	0.000
	EXPCON	9.685	1	9.685	2.033	0.158
	Error	328.759	69	4.765		
	Total	1020.000	72			
	Corrected Total	673.278	71			
12–15	Corrected Model	403.503	2	201.752	13.703	0.000
	Intercept	791.704	1	791.704	53.774	0.000
	Pre-Verbal Reasoning	270.896	1	270.896	18.400	0.000
	EXPCON	131.475	1	131.475	8.930	0.004**
	Error	1118.927	76	14.723		
	Total	5132.000	79			
	Corrected Total	1522.430	78			

**p<0.01

As seen in Table 4, subgroup analysis with reference to age showed that the children who underwent chess training from the age group 12–15 years had significant gains in verbal reasoning compared to the control group.

11.3. Impact of chess intervention with reference to gender on verbal reasoning

Table 5.
ANCOVA between intervention group and gender on verbal reasoning at postintervention.

Tests of Between-Subject Effects
Dependent Variable: Post-Verbal Reasoning

Gender	Source	Sum of Squares	df	Mean Square	F	Sig.
Female	Corrected Model	179.117	2	89.559	9.144	0.000
	Intercept	163.780	1	163.780	16.722	0.000
	Pre-Verbal Reasoning	160.065	1	160.065	16.343	0.000
	EXPCON	14.854	1	14.854	1.517	0.224
	Error	519.097	53	9.794		
	Total	1316.000	56			
	Corrected Total	698.214	55			
Male	Corrected Model	985.165	2	492.582	39.212	0.000
	Intercept	538.423	1	538.423	42.861	0.000
	Pre-Verbal Reasoning	837.427	1	837.427	66.663	0.000
	EXPCON	124.761	1	124.761	9.931	0.002**
	Error	1155.719	92	12.562		
	Total	4836.000	95			
	Corrected Total	2140.884	94			

**p<0.01

As seen in Table 5, subgroup analysis with reference to gender showed that the boys improved in verbal reasoning.

There are not many studies to assess the impact of chess training with respect to gender. However, Blanch, Aluja and Cornadó (2015) found that even though there is no significant interaction effect of gender, the gains of the boys and girls in the various cognitive functions differ. They also found that improvement is seen among boys in verbal reasoning, in the intervention group, compared to the control group.

The results of this study corroborate with those of Sigirtmac (2012) who found statistically meaningful differences in all the concepts tested favoring children trained in chess. However, no significant gender differences were found.

It could be inferred from the above that both boys and girls have significant gains from the impact of chess training, irrespective of their gender.

11.4. Impact of chess intervention with reference to type of school on verbal reasoning

Table 6.
ANCOVA between intervention group and type of school on verbal reasoning at postintervention.

Tests of Between-Subject Effects

Dependent Variable: Post-Verbal Reasoning

Type of School	Sources of Variance	Sum of Squares	df	Mean Square	F	Sig.
Government	Corrected Model	205.191	2	102.596	12.924	0.000
	Intercept	299.204	1	299.204	37.691	0.000
	Preverbal Reasoning	126.149	1	126.149	15.891	0.000
	EXPCON	75.222	1	75.222	9.476	0.003**
	Error	468.357	59	7.938		
	Total	1512.000	62			
	Corrected Total	673.548	61			
Private	Corrected Model	987.229	2	493.614	34.409	0.000
	Intercept	383.497	1	383.497	26.733	0.000
	Pre-Verbal Reasoning	929.496	1	929.496	64.793	0.000
	EXPCON	48.214	1	48.214	3.361	0.070
	Error	1233.715	86	14.346		
	Total	4640.000	89			
	Corrected Total	2220.944	88			

**p<0.01

Children studying in government school alone had a significant increase in Verbal Reasoning as seen in Table 6. The children in the private school were predominantly from the middle to higher income groups, with educated parents. On the other hand, the children from the government schools were from lower to middle income groups, with less educated parents. Further, the private schools offered more opportunities like extracurricular activities for the students in school, which was not so in the government schools. This could be a possible factor in the increase in Verbal Reasoning that was seen only in the government schools.

12. IMPLICATIONS

Built in to the chess training methodology used in the present study is a component that strengthens verbal ability and reasoning. Such a curriculum has obvious benefits leading to academic, cognitive, and whole person development of the child. Studies investigating the impact of chess intervention on cognitive functions or academic performance, to a large extent, have used a small sample or a short duration of chess training. The present study makes a commendable contribution as it has examined the impact of 1-year chess training using an experimental design and randomized sample selection. Further, the inclusion of an active control group counters the operation of placebo effect. The sample size of 150 children, while modest, is large enough to substantiate the findings.

13. FUTURE RESEARCH DIRECTIONS

1. This study had a chess intervention frequency of just one session a week. If the frequency is stepped up, one can expect greater cognitive gains.
2. Further research can be carried out on young adults and senior citizens, to understand whether the cognitive gains could be achieved and cognitive decline could be delayed or arrested, respectively.
3. Research can be done on the impact of chess training on sociobehavioral development of children and in certain specific population segments such as dyslexics, those with ADHD, and low academic performers.
4. Additional research can be conducted to study the impact of chess training on academic performance of children and to study if there is any correlation between chess skill and academic performance.

REFERENCES

Blanch, A., Aluja, A., Cornadó, M. P. (2015). Sex differences in chess performance: Analyzing participation rates, age, and practice in chess tournaments. *Personality and Individual Differences, 86*, 117–121. doi:10.1016/j.paid.2015.06.004

Burton, N. W., Welsh, C., Kostin, I., & van Essen, T. (2009). *Toward a definition of verbal reasoning in higher education*. ETS Research Report 09-33. Lawrence, NJ: Educational Testing Service.

Christiaen, J., & Verholfstadt, D. (1978). Chess and cognitive development. *Nederlandse Tydschrift voor de Psychologie en haar Grensbebieden, 36*, 561–582.

Dullea, G. J. (1982, November). Chess makes kids smarter. *Chess Life and U.S. Chess Federation*, article 10.

Edwards, A. L. (1985). *Experimental designs in psychological research*. New York, NY: Harper & Row.

ElDaou, B. M. N., & El-Shamieh, S. I. (2015). The effect of playing chess on the concentration of ADHD students in the 2nd cycle. *Procedia – Social and Behavioral Sciences, 192*, 638–643. doi:10.1016/j.sbspro.2015.06.111

Ferguson, R. (2000). The use and impact of chess. In Section B, *USA Junior Chess Olympics Curriculum, 53.*

Ferguson, R. F. (1998). Teacher's perceptions and expectations and the Black-White test score gap. In C. Jencks & M. Phillips (Eds.), *The Black-White test score gap* (pp. 273–317). Washington, DC: Brookings Institution Press.

Frank, A., & D'Hondt, W. (1979). Aptitudes and learning chess in Zaire. *Psychopathologie Africane, 15*, 81–98.

Friedland, R. P., Fritsch, T., Smyth, K. A., Koss, E., Lerner, A. J., Chen, C. H., ..., Debanne, S. M. (2001). Patients with Alzheimer's disease have reduced activities in midlife compared with healthy control-group members. *Proceedings of the National Academy of Sciences, 98*(6), 3440–3445. doi:10.1073/pnas.061002998

Horgan, D. D. (1987). Chess as a way to teach thinking. *Teaching, Thinking and Problem Solving, 9*, 4–11.

Joseph, E. (2008). Patent No. L-32958/2009, India.

Joseph, E., Easvaradoss, V., Abraham, S., & Jain, S. (2018). Enhancing verbal reasoning of school children through chess learning. *International Journal of Scientific Engineering and Science, 2*(7), 1-3.

Joseph, E., Easvaradoss, V., & Solomon, N. J. (2016). Impact of chess training on academic performance of rural Indian school children. *Open Journal of Social Sciences, 4*(2), 20–24. doi:10.4236/jss.2016.42004

Kamat, V. V. (1967). *Measuring intelligence of Indian children.* (4th ed.). London: Oxford University Press.
Kerlinger, F. N. (1973). *Foundation of behavioural research*. New York, NY: Holt, Rinehart and Winston.
Kitsis, A. (2006). Benefits of chess for academic performance and creative thinking. Retrieved from https://www.semanticscholar.org/paper/benefits-of-chess-for-academic-perfomance-and-crea-Kitsis/195be2ba795fb1c70f9956c4eefb424e8aa1fd0e
Liptrap, J. (1998, March). Chess and standard test scores. *Chess Life*, 41–43.
Margulies, S. (1991). *The effect of chess on reading scores: District nine chess program second year report*. New York, NY: The American Chess Foundation.
McDuffie, A. (2013). Verbal comprehension. In F. R. Volkmar (Ed.), *Encyclopedia of autism spectrum disorders*. New York, NY: Springer.
Meyers, J. (2011). Why offer chess in schools? In P. McDonald (Ed.), *The benefits of chess in education: Examples of research and papers on chess and education*.
Palm, C. (1990). *Chess improves academic performance*. New York, NY: New York City Schools Chess Program.
Remsen, D. (1998). Churchill school for learning disabilities wins three trophies at nationals. *Chess Life, 53*, 622.
Sigirtmac, A. D. (2012). Does chess training affect conceptual development of six-year-old children in Turkey? *Early Child Development and Care, 182*(6), 797–806. doi:10.1080/03004430.2011.582951
Smith, J. P., & Cage, B. N. (2000). The effects of chess instruction on the mathematics achievement of southern, rural, black secondary students. *Research in the Schools, 7*, 19–26.
Storey, K. (2000). Teaching beginning chess skills to students with disabilities. *Preventing School Failure, 44*(2), 45–49.
Torrance, E. P. (1966). *Torrance tests of creative thinking*. Princeton, NJ: Personnel Press.
Trinchero, R. (2013). *Can chess training improve Pisa scores in mathematics? An experiment in Italian primary school.* Paris: Kasparov Chess Foundation Europe.
Unterrainer, J. M., Kaller, C. P., Halsband, U., & Rahm, B. (2006). Planning abilities and chess: A comparison of chess and non-chess players on the Tower of London task. *British Journal of Psychology, 97*(3), 299–311.
Watson, G., & Glaser, E. M. (1952). *Watson-Glaser critical thinking appraisal.* San Diego: Harcourt, Brace & World.
Wojcio, M. (1995). Chess is very special. *Chess Life, 50*, 767.

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