APPENDIX A
OVERVIEW OF SCIENTIFIC PAPERS ON CHESS IN SCHOOLS

Tables based on: Ortiz-Pulido, Ricardo, et al. "Neuroscientific evidence support that chess improves academic performance in school." *Revista mexicana de neurociencia* 20.4 (2019): 194-199.
URL: https://www.medigraphic.com/pdfs/revmexneu/rmn-2019/rmn194e.pdf

Table 1

Some studies that have found that chess influences mathematical achievement at school

Author(s)	Country	Number of participants	Study objective	Tests	Results
Fernandez-Amigo et al. T1 (Year 2008)	Spain	N = 141 experimental group (79 boys, 62 girls)	Analyze, qualitatively and quantitatively, the utility of instructional materials using chess for teaching mathematics during the second grade of primary school.	EFAI (Factorial Evaluation of Intellectual Aptitudes) Numerical score, reasoning score, ethnographic interview, surveys	Satisfaction was achieved in the utility of the chess - based learning materials for teaching mathematics
Achig and Francisco T2 (Year 2015)	Ecuador	N = 35 experimental group (20 boys, 15 girls)	Test the impact of chess on logical-mathematical reasoning in sixth-grade primary school students	Theoretical chess test before and after, Mathematics class score	The average math class score increased
Guerrero et al. T3 (Year 2015)	Mexico	N = 32 The number of boys versus girls is not given.	Describe the effect of chess on basic mathematical operations in fifth-grade primary school students	Pre-intervention tests, characteristics of the child and the child's mother and father	Better concentration, and memory and higher math class score
Gumede and Rosholm T4 (Year 2015)	Danmark	N = 264 The number of boys versus girls is not given	Characterize the impact of chess in the subject of mathematics in first-and third-grade primary school students	Pre-intervention tests, personal characteristics of the child and of the child's mother and father.	Positive effects in both immigrant and non-immigrant Danish children
Sala et al T5 (Year 2015)	Italy	N = 309 experimental group (169 boys, 140 girls) N = 251 control group (116 boys, 135 girls)	Investigate the potential of online chess lessons on problem-solving abilities in second, fourth, and fifth-grade primary school students	Programme for International Student Assessment (PISA) and chess survey	Highly positive correlation between math score and chess in the experimental group
Sala et al T6 (Year 2016)	Italy	N = 309 experimental group (169 boys, 140 girls) N = 251 control group (116 boys, 135 girls)	Experimental study of chess in fourth grade primary school students using a placebo group	Six tests evaluating mathematics abilities, IEA - TIMSS psychometric test	The chess group was more effective in math skills than the GO group, but not in school activities
Rosholm et al. T7 (Year 2017)	Danmark	N = 323 Test group. N = 159 Control group	Analyze the effect of replacing one mathematics lesson per week with one based on chess instruction in first and third grade primary school students	Mathematics test (including calculations, geometry, pattern recognition, and basic problem solving)	Improvement in the composition of mathematical sequences in the experimental group
Meloni and Fanari T8	Italy	N = 48 experimental group. N = 37 Control group	Analysis of the effects of replacing one maths lesson per week with a chess lesson for primary	Mathematics test (including calculations, geometry, pattern recognition	Improving the formation of mathematical sequences in the experimental group

Author(s)	Country	Number of participants	Study objective	Tests	Results
(Year 2019)			school pupils in the first and third grades	and basic problem solving)	
Tachie and Ramathe T9 (Year 2022)	South Africa	N = 25 experimental group N = 26 Control group The number of boys versus girls is not given.	Analysis of the effects of replacing one mathematics lesson per week with a chess lesson for ninth grade students	Group test	The chess group was more effective in mathematical skills

Table 2

Some papers investigating the influence of chess on reading comprehension in school

Author(s)	Country	Number of participants	Study objective	Tests	Results
Margulies et al T10 (Year 1991)	USA	N = 1118, groups of participants N = 22	Escribe the effect on reading before and after chess instruction in primary school	Degree of reading power test (DRP)	The group of chess students improved more than the average student.
Liptrap et al T11 (Year 1998)	USA	N = 67 Group that did not play chess N = 504	Determine the degree of participation by students in a chess club	Texas Assessment of Academic Skills (TAAS). Texas Learning Index (TLI)	The chess group improved more in math skills than in reading
Duccette T12 (Year 2009)	USA	Experimental group N = 151	Analyze the effect of a chess program on behavior, math, and reading	Philadelphia's behavior grade and attendance, Pennsylvania System of school Achievement (PSSA) Score in reading and mathematics	After 1 year, the group that played chess improved in math and reading, and these values were correlated, while in the control group none of these patterns were present.
Dapica Tejada T13 (Year 2016)	Spain	N = 60 Total Chess group N = 30 (21 boys, 9 girls) Control group N = 30 (20 boys, 10 girls)	Test whether there are significant differences in reading comprehension and saccadic movements (SM*) in boys and girls that play chess.	Chess participation survey, PROLEC-SE battery of tests of reading processes and the King Devick SM test	The chess group improved on the different tests by which they were evaluated, which did not occur in the no-chess group. In addition, there was a correlation between SM and reading comprehension and between chess and SM
Celiz T14 (Year 2020)	Peru	N = 56 Total Chess group N = 27 Control group N = 27	The effect of chess on the reading comprehension of primary school pupils in the third grade	Pre-test and Post-test	Reading comprehension improved

*SM are produced in the eyes when we read, look, or search for information, refers to movement speeds of 500º/S. During these MS, the eyes can remain still for intervals of around 200-300 ms.

Table3

Some papers investigating the influence of chess on personality traits

Author(s)	Country	Number of participants	Study objective	Tests	Results
Filipp et al T15 (Year 2007)	Germany	N = 84 Chess group N = 83 Control group	Impact of chess on mental and academic development in first to fourth grade students, over 3 years.	Basic Intelligence Test Scale Differential Performance Test Ability to Concentrate (TPK) Hamburg Writing Test Questionnaire	The chess group performed above average in reading comprehension, arithmetic, Improvements in attitudes and social behaviour
Aciego et al. T16 (Year 2012)	Spain	N = 170 Chess group N = 60 Control group	Effects of regular chess lessons on intellectual and socio-affective abilities	Performance test WISC-R Self-assessment TAMAI Pretest and posttest External evaluation	The chess group improved in cognitive and socio-affective skills (self-confidence, motivation to learn, attention, visuo-motor coordination,...).
Ramos et al T17 (Year 2017)	Argentina	N = 65 Total (42 boys, 23 girls) Chess group N = 30 (28 boys, 2 girls) Control group N = 35 (14 boys, 21 girls)	Analysis of the differences in cognitive performance between children who practise chess and children who do not practise chess	Ex post facto cross-sectional study Stroop Word Colour Test WISC IV WCST Labyrinth test according to Porteus Multivariate variance analysis	The chess group achieves higher scores in planning, working memory, cognitive flexibility
Joseph et al. T18 (Year 2018)	India	Chess group N = 70 (43 boys, 27 girls) Control group N = 81 (52 boys, 29 girls)	Effects of systematic chess training on verbal reasoning	Pretest and posttest ANCOVA Binet-Kamat Intelligence Test	After 2 years, significant increase in linguistic thinking ability in the chess group, no differences between the sexes
Atashafrouz T19 (Year 2019)	Iran	N = 40 Total Chess group N = 20 Control group N = 20	Effects of chess on problem-solving ability, working memory and concentration for tenth-grade students	Pretest and Posttest, Cassidy and Lang's problem-solving style questionnaire (PSSG), Cornoldi's working memory test (CWMT) and Weinstein and Palmer's learning and study strategies inventory (LASSI)	The chess group showed significantly better results for working memory and concentration.
Gündüz et al T20 (Year 2019)	Turkey	N = 25 Total Speer Trainees N = 20 Peer Trainers N = 5	Impact of chess teaching as peer learning in primary school classrooms	Questionnaires Peer Evaluation Forms Surveys	Improvement of cognitive skills, communication and social behaviour
Sandoval-Tipán and Ramos-Galarza T21 (Year 2020)	Ecuador	N = 60 Total (41 boys, 19 girls) Chess group N = 30 Control group N = 30	Effects of chess on working memory and planning ability in primary school pupils	ENFEN test battery, Labyrinth test according to Porteus, observation questionnaire	The chess group showed significantly better results for working memory and planning ability.
Tanajyan et al T22 (Year 2021)	Armenia	N = 264 Total Distribution of pupils by class level, school	Attitudes towards chess education and its effects on the social behaviour of children in the second to fourth grade	Standardised Interview with Multiple Choice Tests - Rokeach theory of values	The vast majority enjoy playing chess, Positive effect on cooperation behaviour, motivation, honesty, planning, discipline.

Author(s)	Country	Number of participants	Study objective	Tests	Results
		type and gender			
Gao et al. T23 (Year 2021)	China	N = 255 Total Distribution of pupils by class level, school type and gender	Relationships between fluid intelligence, skills in chess and school performance	Raven's Standard Progressive Matrices Survey School exams Multivariate variance analysis	positive correlation between fluid intelligence and school performance, Chess skills correlate with academic performance.
Glukhova T24 (Year 2022)	Russia	1st phase N = 637 Total Chess group 1 N=331 with chess project" teaching programme Chess group 2 N = 160 with "Chess universal" teaching programme Control group N = 146 without chess programme across all phases N = 1571 there-of N = 723 with teaching programme "chess project	Increasing the developmental level of intellectual processes in children by means of chess based on the approach of reflection activity with pupils of the first to ninth grade over 4 years and long-term effect, 18 years in total	Memory test, Visual memory test Analogy tests Raven's Standard Progressive Matrices Correction test Bourdon	Stable improvement of intellectual performance, of the chess groups Developmental advantage is maintained into high school grades
Chitiyo et al. T25 (Jahr 2023)	USA	N = 1286 Total Distribution of pupils by class level, school type and gender	To identify differences in students' perceived benefits of chess by gender and age, as well as by different schools and year groups. To determine Benefits: Enjoyment, self-confidence, organisational skills, motivation to learn, self-efficacy, ability to cooperate, organisational skills.	Retrospective pretest and posttest Multivariate analysis of variance	Motivation to learn highest among primary school pupils and more among girls than boys in all grades, Enjoyment was higher among boys than girls, with primary school pupils having the most enjoyment, Cooperativeness improved most among primary school pupils, Perception of benefits depends on gender and grade level.

to table 1

1. Fernández-Amigo J, Gairín Sallán J. Utilización de Material Didáctico con Recursos de Ajedrez Para la Enseñanza de las Matemáticas Barcelona. España: universidad de Barcelona; 2008, URL: https://www.tesisenred.net/handle/10803/5053
2. Achig F, Francisco J. Artículo Científico-Incidencia de la Enseñanza del Ajedrez en la Asignatura de Matemáticas en los y las Estudiantes del 6to. año de Educación Básica de la Unidad Educativa Hermano Miguel de la Salle-Cuenca en el Período de Enero a Junio de 2012-2015, URL: http://repositorio.espe.edu.ec/xmlui/handle/21000/7049
3. Guerrero SG, Martínez RM, Alonzo MM. EL ajedrez para el aprendizaje de operaciones básicas y números fraccionarios en un grupo de quinto grado de educación primaria. Rev Invest Educ Esc Grad Educ. 2015;6:9-14.
   URL: https://sibi.upn.mx/cgi-bin/koha/opac-detail.pl?biblionumber=197301
4. Gumede K, Rosholm M. Your Move: the Effect of Chess on Mathematics Test Scores. Discussion Paper; 2015
   URL: https://docs.iza.org/dp9370.pdf
5. Sala G, Gorini A, Pravettoni G. Mathematical problem-solving abilities and chess: an experimental study on young pupils. SAGE Open. 2015;5:2158244015596050
   URL: https://doi.org/10.1177/2158244015596050
6. Sala G, Gobet F, Trinchero R, Ventura S. Chess instruction enhance mathematical ability in children? A three group design to control for placebo effects. In: does Chess Instruction Enhance Mathematical Ability in Children? Philadelphia, PA: a Three Group Design to Control for Placebo Effects; 2016
   URL: https://livrepository.liverpool.ac.uk/3002154/1/sala_cogsci-2016.pdf
7. Rosholm M, Mikkelsen MB, Gumede K. Your move: the effect of chess on mathematics test scores. PLoS One. 2017;12:e0177257
   URL: https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0177257
8. Meloni, Carla, and Rachele Fanari. "Chess Training Effect on Meta-Cognitive Processes and Academic Performance." *International Association for Development of the Information Society;* 2019.
   URL: https://doi.org/10.33965/celda2019_201911L048
9. Tachie, Simon Adjei, and Johnson Motingoe Ramathe. "Metacognition Application: The Use of Chess as a Strategy to Improve the Teaching and Learning of Mathematics." *Education Research International* 2022; 2022
   URL: https://doi.org/10.1155/2022/6257414

to table 2

10. Margulies S. The Effect of Chess on Reading Scores. Report. Vol. 10. New York: the American Chess Foundation; 1991. p. 13-25
    URL: https://rknights.org/wp-content/uploads/margulies.pdf
11. Liptrap JM. Chess and Standard Test Score. London: chess Life; 1998. p. 41-3
    URL: https://saintlouischessclub.org/education/research/chess-and-standard-test-scores
12. DuCette J. An Evaluation of the Chess Challenge Program of ASAP/After school Activities Partnerships. Philadelphia, PA: after School Activities Parnerships; 2009. p. 1-13
    URL: http://il-chess.org/non_joom/youthpdfs/BradASAPsummary.pdf
13. Dapica-Tejada R. Influencia del Ajedrez en la Comprensión Lectora y los Movimientos Sacádicos en Niños Madrid. España: universidad Internacional de la Rioja; 2016
    URL: https://reunir.unir.net/handle/123456789/4371
14. Mamani Celiz, Edwin. *La enseñanza del ajedrez para la comprensión lectora en estudiantes de primaria de la unidad educativa "Kalajawira" de la ciudad de La Paz, gestión 2019*. Diss. 2020.
    URL: https://repositorio.umsa.bo/handle/123456789/24961

to table 3

15. Filipp, Sigrun-Heide, and H. Spieles. "Fördert Schachunterricht in der Grundschule die geistige Entwicklung der Kinder." *Abschlussbericht über eine Evaluationsstudie zum Schachunterricht in einer Trierer Grundschule. Trier: ZDiag* (2007).
    URL: https://nsv-online.de/downloads/Endbericht-Abschlusskorrektur13-02-07.pdf
16. Aciego, Ramón, Lorena García, and Moisés Betancort. "The benefits of chess for the intellectual and social-emotional enrichment in schoolchildren." *The Spanish journal of psychology* 15.2 (2012): 551-559.
    URL: http://chessedu.org/wp-content/uploads/social-emotional-benefits-1.pdf
17. Ramos, Larisa, Vanessa Arán Filippetti, and Gabriela Krumm. "Funciones ejecutivas y práctica de ajedrez: un estudio en niños escolarizados." *Psicogente* 21.39 (2018): 25-34.
    URL: http://www.scielo.org.co/pdf/psico/v21n39/0124-0137-psico-21-39-00025.pdf
18. Joseph, Ebenezer, et al. "Enhancing verbal reasoning of school children through chess learning." *International Journal of Scientific Engineering and Science* 2.7 (2018): 1-3.
    URL: http://ijses.com/wp-content/uploads/2018/07/181-IJSES-V2N6.pdf
19. Atashafrouz, Askar. "The effectiveness of chess on problem-solving, working memory, and concentration of male high school students." *Iranian Evolutionary and Educational Psychology Journal* 1.4 (2019): 249-258.
    URL: https://doi.org/10.29252/ieepj.1.4.2
20. GÜNDÜZ, Nevin, and Ü. N. E. R. Umut. "Application and Evaluation of Peer Education Model in Chess Learning." *The Journal of Eurasia Sport Sciences and Medicine* 1.3: 103-115.
    URL: https://dergipark.org.tr/en/download/article-file/1117499
21. Sandoval-Tipán, Luis, and Carlos Ramos-Galarza. "Efectos del ajedrez en el funcionamiento neuropsicológico infantil de la memoria de trabajo y la planificación." *Revista Ecuatoriana de Neurología* 29.2 (2020): 46-51.
    URL: http://scielo.senescyt.gob.ec/scielo.php?script=sci_arttext&pid=S2631-25812020000200046

22. TANAJYAN, Kristine, Nelli MELKONYAN, and Sirarpi MOVSISYAN. "Chess as a social value." *Main Issues Of Pedagogy And Psychology* 19.1 (2021): 32-37.
URL: https://miopap.aspu.am/index.php/miopap/article/download/390/352
23. Gao, Qiyang, et al. "Does perceived chess skills mediate the relationship between fluid intelligence and academic performance?." *Journal of Psychology in Africa* 31.1 (2021): 56-60. URL: https://www.researchgate.net/profile/Chen-Wei-3/publication/349917758_Does_perceived_chess_skills_mediate_the_relationship_between_fluid_intelligence_and_academic_performance/
24. Glukhova, Oksana V. "The Need for Chess in School and Its Role in the Dynamics of Child Development." *Revue internationale du CRIRES: innover dans la tradition de Vygotsky* 4.1 (2017): 161-168.
URL: https://psyjournals.ru/journals/cpp/archive/2022_n4/Glukhova_et_al
25. Chitiyo, George, et al. "Students' perceived benefits of chess: Differences across age and gender." *Journal of Global Education and Research* 7.3 (2023): 214-225.
URL: https://digitalcommons.usf.edu/jger/vol7/iss3/2/