How Chess can be a Cognitive Enhancement Tool?

(Article begins on next page)

HOW CHESS CAN BE A COGNITIVE ENHANCEMENT TOOL?

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ABSTRACT:

The article reports the main results of the Castle research Project 2014-2017 and defines ways for a chess training aimed to develop cognitive and academic skills. The main research hypotheses state that a dedicated protocol of Chess training (psychomotricity on giant chessboard and desktop chess training) improves logical-mathematical skills in 8-11 years old children, metacognitive skills in 5-11 years old children, psychomotor skills in 5-7 years old children. Protocols are designed to develop in children habits of mind that help them in systematic reflection in academic or real-life situations. The research was performed on 50 classes of primary school in Italy and Spain and follows a pre-post experimental design with control group. More than 5,000 observation has been collected about mathematic abilities, metacognitive abilities, psychomotor abilities. Results highlights that for a successful use of chess as a tool for cognitive enhancement it is necessary to focus on "how to teach the game" rather than on the game itself. Future research have to focus on the construction of targeted activities - supported by chess - closely related to the skills and contents subject to enhancement. Proper activities can build and progressively consolidate in children broader "ways of thinking" to be applied in academic and real-life situations.

KEYWORDS: Chess in schools, Cognitive enhancement, Metacognitive teaching, Chess for cognitive enhancement.

INTRODUCTION

Can chess training help to improve cognitive, meta-cognitive and psychomotor skills in young children? The CASTLE (acronym for "Chess curriculum to Advance Students' Thinking and Learning skills in primary Education") project is a research project funded by the Erasmus+ European Program, realized from 2014 to 2017 in Italy and Spain with an initial partnership of Alfiere Bianco (White Bishop) in Italy, Deutsche Schulschachstiftung (the German school chess foundation) in Germany, Club Ajedrez 64 Villalba in Spain, together with the research group of Experimental Pedagogy at the Department of Philosophy and Education at the University of Turin (DFE-UniTo). In the monitoring of results were also involved the Regional School Office for Piedmont and the Regional School Office of Madrid. The project aims to produce chess training protocols for children

[1] Roberto Trinchero is responsible of the Literature Review and of the Methodology; Daniela Robasto is responsible of the Introduction and of the Discussion. Both authors are responsible of Conclusions.

from 5 to 11 years, and the research, here outlined, aims to control whether the chess activities can foster the development of cognitive and metacognitive skills. The main research hypotheses state that: (a) a dedicated protocol of Chess training improves logical-mathematical skills in 8-11 years old children; (b) a dedicated protocol of Chess training improves metacognitive skills in 5-11 years old children; (c) a dedicated protocol of psychomotor activities on giant chessboard improves psychomotor skills in 5-7 years old children.

The research follows an experimental pre-post design with control group. A narrative diary was compiled by teachers and instructors to document ongoing strengths and critical points of the activities.

LITERATURE REVIEW

The question of chess as cognitive enhancement tool is largely debated (Scholz et al., 2008; Sala, Gorini, Pravettoni, 2015; Sala et al., 2016; Burgoyne et al., 2016; Sala, Foley, Gobet, 2017). A meta-analysis about chess as a tool to improve performance in mathematics (Sala & Gobet, 2016) shows that exposure to chess instruction of primary and middle school students is - in the short term - associated with positive results in mathematics performance, but several current experimental designs show lacks in considerate: (a) the potential placebo effects of chess instruction, (b) the cognitive mechanisms underlying the transfer from chess to mathematics skills, and (c) the appropriate type and duration of the teaching for this transfer to occur.

Research questions have been focused on the possibilities of *far transfer* (Laker, 1990) between chess skills and academic skills. Far transfer refers to both the ability to use what was learned in one setting to a different one as well as the ability to solve new problems (Perkins & Salomon, 1988). Two main explanations have been adduced to support the hypothesis that skills acquired with chess can transfer to other domains. The first hypothesis states that chess requires decision-making skills and high-level processes (i.e. to acquire, select, represent, retain information and to use it to guide behavior) similar to those used in mathematics and reading (Margulies, 1992). The second hypothesis states that being chess a demanding task involving focused attention and problem solving, playing chess should strengthen these cognitive abilities and thus be beneficial for children's school performance (Bart, 2014). From the theoretical point of view both these hypotheses show many limits (Sala & Gobet, 2016).

An important finding (Sala, Foley, Gobet, 2017) outlines that the exposure to unstructured chess activities (i.e. free game with peers) seems not to provide any particular benefit. At the opposite, a set of chess activities specifically designed to train cognitive/academic skills may be more effective. Based on these results, the right research problem should be not whether chess practice improves or not cognitive/academic skills but *which type of chess training* is effective to enhance these skills. The key element is not the game itself but the didactic approach used by chess instructor. Used in particular manner, the game offers to instructor several possibilities to aid the pupils to practice a large set of skills and attitudes. In this process, the game is nothing more than a support tool for a targeted didactic action that specifically aims to develop metacognitive skills and appropriate *habits* *of mind* (Costa & Kallick, 2013) in pupils. Using chess situations, the instructor can lead the pupil to systematically reflect on his/her own behaviors, choices, attitudes, and can aid him/her to develop more general habits and strategies to face several problem in school and in real life.

METHODOLOGY

The experimental activities consist in session of psychomotricity on floor chessboard for 5-7 years old children and desktop chess training for 8-11 years old children.

Psychomotricity sessions use a floor giant chessboard to perform activities designed to make children progressively aware of their sensory-motor skills, through the play and the activation of their cognitive resources to solve simple problems (*cognitive activation*, Burge, Lenkeit, Sizmur, 2015). This motor experience takes place in a privileged and protected space, the chessboard, and becomes for children a “magical” experience, a bridge between reality and imagination, mixing game and awareness to know oneself and build interactions with others in a fair, responsible and cooperative way. Children learn to take care and control of the body, of its expressive possibilities and of relationship through movement, and become aware of their perceptions and physical self. The activities aim to gradually develop in the child:

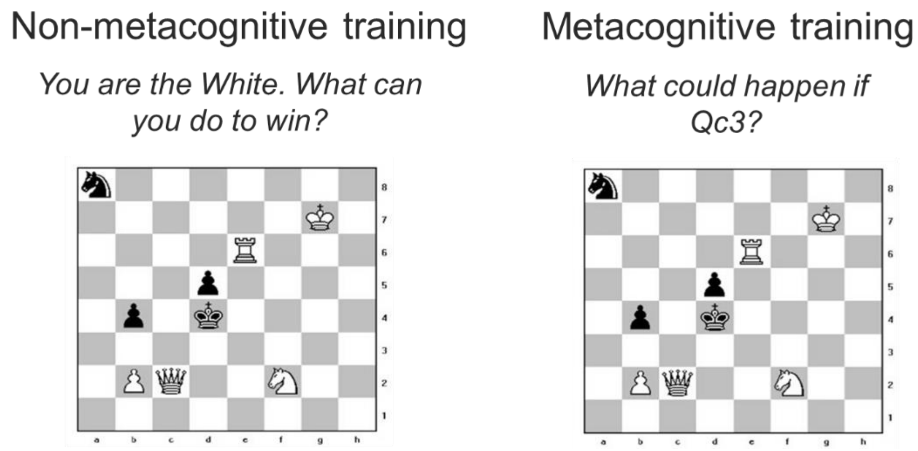
(a) The ability to read, understand and interpret messages from one’s own body, from that of the other and respect them both.
(b) The ability to express oneself and communicate through it in order to improve its perceptual capacities.
(c) The ability to orientate in space and time, to know different rhythms and experience them.
(d) The ability to read spatial coordinates.

Psychomotor activities are designed to have an impact on children spatial orientation, motor coordination, expression of feelings with body language, ability to perform a delivery on floor chessboard, ability to count forward-backward, ability to use terms to indicate space position, ability to provide information for following a path on floor chessboard.

Desktop chess training use metacognitive approach to foster the systematic reflection of the pupil on his/her own behavior in chessboard situation. The instructor proposes sessions with several mini-games in which the aim is not to “teach the right move” but to induce pupils to grasp the key-details, to define lines of action, to reflect on proper own action and change it if necessary.

Figure 1 shows an example of metacognitive and non-metacognitive approach in chess training. In non-metacognitive training, the instructor asks simply to the pupil to formulate a move to win. In metacognitive training, the instructor asks to the pupil to consider all possible threats and unforeseen events as well as the opportunities that the move opens, even if it is not the best possible move.

Fig. 1 – Metacognitive and non-metacognitive training



Examples of stimulus questions used by instructor are: (a) What do you want to achieve now? What should you do first? (b) What could happen if …? (c) Verbalize the reasoning that led you to do this move… (d) Choose a move and consider the consequences. What are actual threats to this piece? (e) How many moves would be necessary to … ? What could your opponent do in these moves? (f) What are possible alternative ways to …? (g) What are the similarities between this situation and other problems you have already faced? (h) What worked well in your action? What could you have done better? Can you apply this to other situations? (i) As you have seen in chess training, how you could solve this mathematical problem: …?

The more general purpose of the training is to develop in the student a reflective habitus of attitude and behavior to be reproduced in other situations of school and daily life.

The research sample is made up of 50 classes of primary school in Italy and Spain, not randomized (accidental sampling). The research follows a pre-post experimental design with control group and has collected more than 5,000 observations (in three years) with three instruments:

(a) Observation grid of psychomotor abilities for children 5-7 years old. Grids are compiled by an external member of research group and by the teacher of the class.

(b) Mathematical skills test for children 8-11 years old (three versions for grade 3, grade 4 and grade 5) with items extrapolated from surveys IEA-TIMSS and OECD-PISA.

(c) Metacognitive skills test (Panaoura, Philippou, 2007). The test is designed to measure metacognitive skills in mathematics with item like “When I encounter a difficulty that confuses me in my attempt to solve a problem I try again”, “After I finish my work I know how well I performed on it” (possible answers: 1=never, 2= seldom, 3=sometimes, 4=often, 5=always).

At the end of the desktop chess activities, the pupils do also a test on chess skills.

Data analysis was performed with comparison of percentage gain between experimental group and control group.

DISCUSSION

For the psychomotricity activities, main results are depicted in Table 1. In several abilities experimental group perform significantly better than control group, but the data analysis shows only a large difference in expressing feelings with body language (46% of pre-post gain vs. 22% of control group), counting forward-backward (27% of pre-post gain vs. 14% of control group) and using terms to indicate space position (43% of pre-post gain vs. 15% of control group).

Table 1 - Main results for the psychomotricity activities

Ability	*Chess-trained improving*	*NOT Chess-trained improving*
Spatial orientation	26%	23%
Motor coordination	35%	29%
Express feeling with body language	**46%**	22%
Performing a delivery on floor chessboard	40%	33%
Counting forward-backward	**27%**	14%
Use terms to indicate space position	**43%**	15%
Provide information for following a path	45%	27%

For the desktop chess activities, main results are depicted in Table 2. In several abilities experimental group perform significantly better than control group, but the data analysis shows only a large difference in performing hypothetical reasoning on single-digit subtraction (28% of pre-post gain vs. 14% of control group), performing logical reasoning on available space in a sheet (26% of pre-post gain vs. 14% of control group) and choosing the best rail route (34% of pre-post gain vs. 16% of control group).

Table 2 - Main results for the psychomotricity activities

Ability	*Chess-trained improving*	*NOT Chess-trained improving*
Hypothetical reasoning on single-digit subtraction	**28%**	14%
Calculate distances, division	18%	13%
Calculate quantities, division	28%	20%
Logical reasoning on available space in a sheet	**26%**	14%
Choose the best rail route	**34%**	16%

With refer to metacognitive ability test (Table 3) the broader difference is in finding alternative way to solve a problem (33% of pre-post gain vs. 1% of control group).

Table 3 - Main results for the psychomotricity activities

Ability	*Chess-trained improving*	*NOT Chess-trained improving*
Realize that you have not understood a topic	30%	20%
Find alternative way to solve a problem	**33%**	1%

These results are substantially consistent with what is expressed in the meta-analysis of Sala & Gobet (2016): the improvements in some skills and attitudes are visible, but only in relation to the elements touched by the chess instructor during the intervention. There is no automatic transfer between chess skills, mathematical skills, metacognitive skills.

CONCLUSIONS

The literature review and the research results leads us to conclude that in order to successfully use chess as a tool for cognitive enhancement it is necessary to focus on "how to teach the game" rather than on the game itself. As noted in previous research (Trinchero & Sala, 2016), the instructor approach makes the difference.

It is important to design targeted training activities, aimed at improving specific skills. These activities should be conceived to build and progressively consolidate "ways of thinking" that the students could bring into academic and real-life tasks, adequately supported by the instructor.

It is also important the training of chess instructors. This is the key element that can lead to an effective use of chess as a cognitive enhancement tool. Research shows that chess can be a "tool to think" only with a precise didactical protocol and properly trained instructors.

Ultimately it is important to develop more accurate measurement protocols to intercept less evident changes promoted by the training protocols. Some existing tests seems not fully adequate to effectively detect the real effects of the training.

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