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Chess and Education

Gülçin Karakuş

Abstract

This review presents how chess improves student abilities and underlines inferences about chess and its educational benefits. In this study, quantitative samples, experimental designs, or test scores of studies are not the main focus. Numerous empirical studies and limited review studies about chess instruction in the literature express the effect of chess on students' success and mental skills. However, almost all of these studies address only positive effects; this review attempts to explain *how* chess achieves this success. What are the other components of this effect? Is it possible to determine how chess impacts education? The question is how and why chess is considered so effective.
Is it possible to present examples by linking basic features of chess, lessons, and cognitive structures?
Keywords: chess, education, students

Chess Game

An Indian proverb says, "Chess is a sea in which a gnat may drink, and an elephant may bathe." Chess, a traditional strategy game, was first found in India about 1,500 years ago (Joseph et al., 2016). Legend has it that an Indian king told a sage to develop a tool to increase children's thinking skills and make them better warriors on the battlefield. The result is chess. Over the years, after the invention of chess, the game has spread worldwide (Joseph et al., 2016).

Bilali´c et al. (2007) define chess as the king of board games. Similarly, Köksal (2016) expands on this definition and indicates it is known as the game of kings, an offensive educational activity with many features, and a perfect mind sport in predicting creative intelligence. Şeb and Bulut Serin (2017) add that chess fully uses the mind. Maas and Wagenmakers (2004) emphasize three basic features of chess: tactical skill, decision-making, and knowledge of how to finish the game. Trinchero (2013) states that chess is the most popular game associated with intelligence, strategy, and logic. It presents students with various problem situations in a competitive environment, thus increasing their creativity (Ferguson, 1995). On the other hand, Unterrainer et al. (2011) define chess as a game of tactics depending on the probability of correctly predicting the combinations of moves and the results of those combinations. Moreover, Horgan and Morgan (1986) emphasize that chess has been called efficient in cognitive psychology, yet it is a highly complex game that enables people to think, use their cognitive abilities, plan, and execute these plans well.

Chess improves students' planning ability (Dauvergne, 2000). When encountering a problem in chess, one makes a plan, tries the plan, and sees the positive or negative result. The results of this experience influence how one faces similar problems in the future. A systematic control mechanism is formed in the student's mind, and the student gains critical thinking skills with all these stages (Milat, 1997). Concerning chess and planning skill, Unterrainer et al. (2011) add that chess requires a high level of mental planning, since individuals who are good at chess also have high planning skills, and they showed better planning performance than non-chess players, especially in difficult problems.

Some researchers define chess by analogy with different concepts. For instance, Okur (2009) expresses that chess is similar to life; the rules in the game of chess are the rules in the ordinary course of life. For example, a touched stone is taken as similar to the promise made in life; if you promised, it must be kept.

Simon and Chase (1988) liken chess to Drosophila, a type of fruit fly, because of their small size, ability to breed easily in large numbers, and being inexpensive to maintain. In addition, experiments with Drosophila progress relatively quickly due to their ability to produce a new generation in 9-10 days (Simon & Chase, 1988). These reasons allow research to be conducted with many samples using less resources with faster outcomes. Likewise, chess is a game that enables a connection between knowledge and understanding in a short time and allows for a deeper investigation of specialization in the game (Cowley et al., 2008). Chess is not just a strategy game played by two opponents moving pieces on a board. To understand chess, it is necessary to look at the game from different angles. Its depth cannot be understood in simple definitions. Chess is more than just a game; it is a science. It is also an art with a historical process and intellectual accumulation that inspires societies (Akay, 2017).

Chess is a game for people of all ages that develops memory, improves concentration, encourages logical thinking, promotes imagination and creativity, teaches independence, develops capability, inspires self-motivation, shows that success rewards hard work, develops scientific ways of learning, improves mathematical thinking and ability to do research, enhances ability to interact, improves school work and grades, opens up the world, enables one to meet interesting people, and it is cheap and fun (Ferguson, 2006). In chess, before you make a move, you need to know how your opponent will react to that move. To make the right decision, you need to tap into your memory, logic, common sense, and intuition skill sets. Interestingly, there can be more moves on the chessboard than the number of atoms (Kasparov, 2010). Maybe that is why the game has remained popular throughout the ages and is still unsolved (Kaynar, 2014). It is as complex and fascinating today as when it arose in India about 1,500 years ago (Holding, 2021).

Advantages of Chess

The advantages of chess are:

- Chess prevents students from acquiring bad habits, teaches them the importance and necessity of acting in a planned manner, helps students to think correctly and quickly, and improves their ability to approach events with correct interpretations (Dunkin & Precians, 1992).
- Chess enables the examination of individual differences in the cognitive process (Ortiz-Pulido et al., 2019).
- Chess positively affects and develops students' personality and character. It gives a sense of "self-confidence" and improves this feeling, enables them to know their strengths and abilities better, and helps reveal their strengths and abilities (Mahmudov et al., 2020).
- Chess teaches students not to give up the game when defeated (Joseph et al., 2016).
- Chess gives the student the habit of concentrating on a single subject (Dauvergne, 2000), helps to understand better and comprehend other course topics, and directs students to do research by putting science at the forefront (Wilkenfeld & Hellmann, 2014). Students adopt a skeptical approach to the subjects, purifying them from rote

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mentality. It turns people into thinking, researching, and judging beings and creates an environment that leaves them free in their creativity (Dauvergne, 2000).

- Chess enables students to take great pleasure from success and makes them even more successful (Bilali´c et al., 2009).
- Chess education is beneficial in areas such as students' general intelligence, concentration, self-control, analytical thinking, and reading skills (Gobet & Campitelli, 2006).
- Chess quickly reveals a negative side of people, a deficiency, or a behavior disorder. It teaches one to follow the rules, play friendly, accept losing, celebrate the winner, and it helps students socialise and establish close friendships (TCF, 2014).
- Chess provides some skills that cannot be acquired by traditional teaching methods and the emergence of latent skills; it develops logical thinking skills, self-confidence, self-worth, communication, and the ability to notice different structures (İbrahim, 2014).

Why Is Chess So Effective for Education?

The first studies on the positive effect of chess on education date back several decades. The positive impact of chess on spatial abilities (Horgan & Morgan, 1989; Van Zyl, 1991), mathematics achievement (Christian, 1976), logical thinking ability (De Groot, 1978), and IQ score (Van Zyl, 1991; Dullea, 1982; Palm, 1990; Ferguson, 2000) are stated in the literature. As a universal game, chess has increased the quality of education and contributed to significant developments in education for many years at the primary school level in countries such as Norway, Sweden, Canada, Israel, and Switzerland (Alifirov et al., 2018). Different researchers focus on various aspects of chess and education. For instance, Meyers (2005) states that chess enhances learning since it improves a student’s ability to focus, visualize, plan, weigh, analyze concretely, and think abstractly. Similarly, Ferguson (2006) indicates that chess improves learning since playing chess improves logical thinking. The reason is that a student needs to save and protect the king constantly; to avoid making a big mistake during the game, the student should ensure integrity (Ferguson, 2006). Unlike these studies, Rifner (1992) researched the relationship between poetry and chess, and determined that there was no relationship between academic achievement in poetry and chess.

One reason why chess is effective in education may be that it improves students’ perspectives (Gao et al., 2019). Playing chess allows one to see alternatives, make new decisions that suit the current situation, and instantly see the results of these decisions. Different intellectual skills are used simultaneously in chess (Aciego et al., 2012). The goal of the strategy created with all these skills is to find the way to victory. That type of strategy, and the mental effort involved, changes depending on each move of the opposing player, which causes new ways and new results to be sought with that move (Aciego et al., 2012). During the game, the student recodes all the movements unconsciously, tests which alternative is and is not suitable; and, depending on this continuous feedback, the scheme in the student's mind is renewed and developed to adapt to constant change (Horgan & Morgan, 1986). Therefore, chess training at an early age is more effective since it is increasingly difficult for mental schemes to change in later years (Horgan & Morgan, 1986). The ability to see more possibilities at an early age, to take more risks, and to make easier decisions provide the student with the ability to solve problems more easily in later years (Horgan & Morgan, 1986).

Another reason chess positively affects education may be that the game provides feedback to the student on the process, whether it is a negative or positive outcome (Allen & Main, 1976). Chess instantly gives feedback to the step taken as a punishment or a reward. By seeing more and different alternatives, students go beyond usual thinking patterns. Seeing alternatives and having immediate feedback enriches the learning environment, which positively affects cognitive skills (Allen & Main, 1976).

An additional essential element between chess and education can be transfer. For instance, students can have learning experiences, methods for solving problems, and techniques for reasoning while playing chess. The student can transfer these skills to education. This approach has achieved limited success (Grotzer & Perkins, 2000). To see the positive effect of chess on education, it is crucial to determine how chess contributes to problem-solving and reasoning skills. Just as the knowledge of geometry contributes to mathematical success due to its many common points, chess has been studied for a long time to explore how it contributes to mathematics success (Gobet & Campitelli, 2006).

Similarly, while solving a problem, the student thinks about all the ways to solve the problem. Chess requires the students to consider all the possible consequences of their decisions. For example, when the student moves a piece somewhere, there are ten possible moves, and each of these ten moves also creates the probability of ten moves. Thus, the student has to think about every possibility (Simon & Chase, 1988; Trinchero, 2013). Correspondingly, Bart (2014) explains why chess increases success in education as follows: to play chess, the student needs to see and use chess positions, the results of a move, and the connections between chess pieces. The player sees the possibilities of 32 chess pieces moving in 64 squares, and it is crucial for the player to anticipate where each piece may move and what might happen due to that movement. These coordinated cognitive skills, necessary to gain proficiency in chess, are likely to be transferred to mathematics learning and related areas that require understanding, induction, analysis, and evaluation of complex phenomena (Bart, 2014). This explains the possible cognitive benefits of chess in education (Bart, 2014).

Chess-Playing Students

A student who prefers the game of chess does not start the game with superficial enthusiasm like students who favor basketball or football (Aciego et al., 2012). Students who play chess are more adaptable to school than others (Aciego et al., 2012). Students are mainly inclined to sports activities such as basketball or football, which are more preferred but have fewer academic features (Aciego et al., 2012). However, it cannot be said that the relations of the students who tend to these activities with the school are very good (Aciego et al., 2012). When their academic achievements are compared, it is seen that students who prefer chess are more successful (Aciego et al., 2012). These students state that their attitudes toward education are more optimistic, compatible with teachers, and have fewer problems with people (Aciego et al., 2012). Teachers also support this view, stating that students who prefer chess are more likely to study, have better relations with school, are more confident, and are happier (Aciego et al., 2012). The reason could be that chess-playing students look for more and different ways and want to try more options and different methods. This provides fluency and originality; therefore, they make better decisions depending on their chess experience (İbrahim, 2014).

Unfortunately, the rapid change in technology today prevents students from playing chess (Willingham, 2010). When technology and mobile applications are quickly developing and

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increasing, students' attention is directed towards more than one activity simultaneously (Trinchero, 2013). Consequently, their attention span is short (Trinchero, 2013). However, chess requires concentration because the student must focus on one piece and see its relationship to other pieces, recognize threats, defenses, tactics, and strategies (Trinchero, 2013). The student should understand that chess can be won with attention (Trinchero, 2013). Moreover, Graham (1985) indicates that when the student plays chess, they see the relationship between the whole and the pieces and the consequences of a move on the board; therefore, their attention span expands.

Chess Expertise

Chess expertise is classified with similar expressions in the literature (such as novice and expert). Horgan and Morgan (1986) define chess learning stages: novice (learner recognizes the facts), advanced beginner (learner begins to use rules), competence (learner sees complex patterns), proficiency (learner develops intuitions), and expertise (learner operates automatically). In becoming a chess expert, a student first acquires knowledge, and secondly uses this knowledge and gains experience (Horgan, 1987). Thirdly, they specialize in analytical thinking like a universal player with knowledge and experience (Horgan, 1987). However, chess education is long-term (Ericsson et al., 1993). The different possibilities that may occur with each move necessitate this situation. A chess player not only tries to make the right move and gets instant feedback but also constantly keeps in mind typical maneuvers, searches for different variations, interrogates, and tries to find innovations that they can use against their opponent so that the student continues to receive continuous training (Ericsson et al., 1993). As an experienced scientist planning an experiment, carrying it out, analyzing the data, and making conclusions—or, like a composer writing a song—the chess master must practice constantly. In this way, they organize what they know and connect it as new knowledge with previous knowledge (Campitelli & Gobet, 2008).

There are different opinions in the literature on the effect of chess playing time on expertise. Grabner et al. (2007) indicate that playing chess for a long time is the most obvious factor in gaining expertise in chess. However, Bilali´c et al. (2007) state that experience in chess does not solely depend on how many years and games have been played. Further research is needed to explore the relationship between these practices and intelligence, and how much they both affect chess ability. For this reason, it is necessary—albeit difficult—to examine the effects of both intelligence and practice on chess.

Chess and Mathematics

Literary review indicates that chess increases success in mathematics (Smith & Cage, 2000; Rosholm et al., 2017; Sala et al., 2015). Having the ability to play chess can help students learn some educational patterns more easily. For example, students who are successful in chess are more successful in numerical patterns and calculations (Ferreira & Palhares, 2008). In the mathematics lessons and chess games, the student should think similarly. In mathematics, the student should establish a connection between what is asked and given in the prompt, determine their goal, and evaluate what they must do to achieve it. Just like a move in chess, the student should anticipate the steps they can take and evaluate whether it is the correct choice. In this way, thinking reflectively will improve their problem-solving skills (Yıldız, 2020). In mathematics, just like in chess, it is important for the student to constantly question their decisions and determine what is needed for a solution. Therefore, the student realizes that chess is not a game of chance but can win the game by using their own effort. If

this positive effect of chess is used in mathematics, fear of mathematics can disappear (Trinchero, 2013). With motivation and attention, mathematics can also be seen as fun. Therefore, the success which is realized with chess can also be transferred to mathematics lessons (Trinchero, 2013).

Noticing similar structures in mathematics and chess requires determining a general strategy and predicting options and possibilities (Hong & Bart, 2007). With chess, the student evaluates alternatives, focuses on fundamental factors, avoids distractors, and tries to reach the planned result with original and creative solutions. In problem solving, previous experiences are used. Therefore, it can be stated that chess has a positive effect on mathematical success since it improves students' meta cognitive skills (Kazemi et al., 2012). Like a good problem-solving student, a talented chess player creates many schemes in their mind, both of whom make predictions for the future using their existing schemes and the possibilities of solutions that have already been tried and were successful (Kazemi et al., 2012).

In the study conducted by Barret and Fish (2011), the effect of chess on the mathematics achievement of special education students was examined. The experimental group received less mathematics lesson hours than the control group, but they were still more successful than the control group in mathematics achievement. In this case, it can be said that chess training instead of reduced mathematics lessons, is effective in increasing success (Barret & Fish, 2011). However, it is unreasonable to argue that chess teaching may be responsible for improvements in basic mathematical skills such as multiplication, correct operation of algebra problems, or geometric proofs (Smith, 1998).

Chess and Reading

Some studies in the literature indicate that chess improves reading skills (Milat, 1997; Marguiles, 1991; DuCette, 2009). The increase in students' reading skills can be linked to their visualizing concepts and movements in chess (Milat, 1997). Thus, the student can visualize the text they read more easily in their mind. For this reason, they can interpret and understand what they read better, and their reading skill can improve (Hirsch, 2003). In a study conducted by Milat (1997), participants' perspectives with high reading scores were collected. Participants expressed that those who play chess are already a gifted group, and that the participants who play chess with these students are also positively affected by their gifted partners. However, contrary to the view that chess is only effective for gifted students, Horgan and Morgan (1986) and Scholz (2008) state that chess is beneficial for intellectually gifted students and students with learning disabilities or hyperactivity. Finally, Marguiles (1991) states that if there is a relationship between chess skill and reading skill—that is, if the same cognitive skills are required for both—then chess skill increases reading skill. However, Marguiles (1991) admits that such a claim is also speculative.

Pygmalion Effect

The Pygmalion effect may be the reason for chess's positive effect (Duellea, 1982). The Pygmalion effect is the realization of the expected result. Chess achievement may have increased due to training of students who receive chess education in a special environment with the teacher's effort (Duellea, 1982). For this reason, it may not be possible to talk about the effect of chess alone in this success (Duellea, 1982).

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Christian (1975) conducted a study titled “Chess and Cognitive Development” (as cited in Duella, 1982). In this study, students who were taught chess scored somewhat better than the control group (who did not receive any training on chess) on various Piaget’s tests for cognitive development. However, Christian (1975) also states in his work these results may be due to the Pygmalion effect. This means that a special education given to a certain group of students results in a positive result. In this context, these and other studies carried out in this way need to be supported, expanded, and approved from different angles.

There are certain cognitive abilities (e.g., planning, problem solving, memorizing) that a student must have in chess. These cognitive abilities are developed by the continuous game play and enable the development of other cognitive skills (Sala et al., 2017). With the development of concentration and problem-solving skills, especially in mathematics, students can increase academic success (Sala et al., 2017). While such an explanation of the effect of chess in education is logical, it needs further exploration and elaboration. Research on the effect of chess in education needs to present findings on cognitive abilities and academic results. It is important to state whether there is a Pygmalion effect in experimental studies, the place of cognitive processes in the effect of chess on academic success, and the appropriateness of the type and duration of the training provided. Sala et al. (2017) suggest that chess training can be given to both groups to eliminate the placebo effect. In this case, training designed to improve cognitive and academic skills can be given to the experimental group, thus eliminating the Pygmalion effect (Sala et al., 2017).

Chess, Individuals, and Society

The positive effect of chess on both the individual and the social structure is expressed in the literature. Grabner et al. (2007) express that individuals who are successful in chess are the ones who can control their emotions more easily and have self-regulation skills. Joseph et al. (2016) add that chess helps students to be more attentive and thoughtful. Margulies (1991) states that chess increases an individual's self-confidence, and individuals who have self-confidence play chess better. Moreover, Akay (2017) states that chess has a structure which contributes positively to an individual's character and social identity.

Chess is one of the tools that can solve psychological problems, since it is a game that can be practiced alone (Kulaç, 2006). Far from monotonous, chess contains many beauties and arouses admiration. Chess is a good friend with whom children can share their loneliness occasionally, and it is an occupation that can keep students away from misbehavior (Kulaç, 2006). Many mothers and fathers state that they can sleep comfortably thanks to the chess games their children play (Erhan et al., 2008).

Chess improves the individual’s observation skills (Puddephatt, 2003) and increases their awareness (Kiesel et al.,2009). The student notices important and unimportant parts of the position during the game and is conditioned to observe and to be constantly attentive. The effect created by this observation is transferable (Artise, 1973). With this transfer, the student distinguishes the more important issues while preparing for an exam; for example, they notice the small details of the text they read (Bransford et al., 1990). With this observation, the student goes deeper into the existing knowledge. Students use this awareness, which was learned with chess, for their benefit in many lessons (Artise, 1973). In the study conducted by Liptrap (1998)—according to the opinions of teachers, students, and families—chess improves some personal characteristics such as patience, observation, creativity, perseverance, respect for others, anger management, sportsmanship as well as other skills.

Furthermore, chess acts as a social bridge in the school, allowing students of different ages, races, and genders to communicate and interact (Rose-Redwood, 2010). It teaches the formation of friendship, team spirit, sportsmanship, and competition among students. Chess teaches to win games gracefully and not to give up when defeated (İbrahim, 2014; Joseph et al., 2016).

Learning Chess as an Adult or a Child

There are differences in the process of learning chess between an adult and a child (Horgan & Morgan, 1990). Although both learn in the same way, the child has less difficulty. Since they are young, they are more heuristic, avoid details, and learn by simplifying what is learned (Horgan, 1987). This is where the Piaget's schema arises. A child's schemas change faster than an adult's does. A child adapts to the next schema (Horgan, 1987). In addition, children learn from their mistakes without any problem (Yerushalmi & Polingher, 2006). Mistakes do not disturb them, as they receive immediate feedback due to the nature of chess; the next correct move is enough for them (Horgan, 1987). Making mistakes is not a problem for a child (Munro, 1999). The reason can be the child's tendency concerning calibration which is the subjective and objective evaluation of one's knowledge (Alba & Hutchinson, 2000). Most of the time, while this is difficult for an adult, a child can easily handle it. Scores in chess achieve this calibration. The child evaluates themselves as clear and real, whether their score is high or low (Horgan, 1987).

Another element that makes it easier for children to learn chess can be entertainment (Iida, 2003). It can be said that children who like difficult tasks enjoy playing chess, but it is not clear how having fun and practicing chess affect each other. In this context, having fun while playing chess may create a desire to play more (Bruin et al., 2014). Or vice versa. The more the children play and practice chess, the more fun they can have (Dauvergne, 2000). In this case, it will be effective for teachers to follow the students who play chess, to examine their motivation and whether they have fun or not (Bruin et al., 2014).

Furthermore, the fact that mainly children play chess causes some limitations in sample studies about the game (Schneider et al.,1993). Individuals who learn chess early on generally stay away from the game in adulthood for some reasons. Therefore, research about chess tend to focus on children. This situation causes a narrowing of the sample of studies on chess (Bilali´c et al., 2007). In addition, if children do not succeed in the first games, they can quit chess (Saaty & Vargas, 1980). As students who are demoralized and unsuccessful tend to quit the game (Saaty & Vargas, 1980), it is inevitable to work only with good students. This also limits studies on how much progress has been made in playing chess (Bilali´c et al., 2007).

Chess and Intelligence

Chess and intelligence are constantly associated in that chess requires intellectual thought (Grabner et al., 2007). Chess is perceived as the best intellectual activity; yet, it is impossible to say that intelligence and chess have a very strong correlation (Bilali´c et al., 2007). Research is generally based on only one factor such as the relationship between chess and intelligence. In this case, other factors such as how much practice is done, and how many years of experience is necessary are ignored (Bilali´c et al., 2007). Although intelligence is important in chess, effective chess training is also important (Horgan, 1987).

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Whether chess is effective only for individuals with medium or high intelligence levels, or whether it provides improvement at a low intelligence level, has been discussed for a long time (Frydman & Lynn, 1992). Intelligence can affect the acquisition of a skill in different ways (Lane & Chang, 2018). Despite being given the same level of training, more intelligent individuals can learn chess structures faster than less intelligent individuals (Sternberg, 1986). These individuals may notice the problem earlier. If this is true, then more intelligent individuals are expected to play chess better. However, some studies state that innate intelligence does not greatly affect chess (Ericsson & Charness, 1994, as cited in Waters et al., 2002). This problem is because there are no detailed studies explaining the relationship between cognitive skills and chess, and it is not very easy to reach data that will provide such a connection (Burgoyne et al., 2016). This is because intelligence is a multidimensional and complex psychological structure. A measurement that can be made between intelligence and chess skill may not be very accurate or valid as only an estimated result can be obtained (Burgoyne et al., 2016). Therefore, it is difficult to explain the effect of chess on education with intelligence alone (Waters et al., 2002; Bilali´c et al., 2007).

Unlike general belief, in a study conducted by Bilali´c et al. (2007), it is stated that intelligence is not an important factor in chess and even has a nearly negative impact. This interesting result explains that focusing on a single dimension in the real world can be dangerous where many different factors are effective together. According to the views of experienced chess players, chess improves a person's general intelligence, concentration, analytical thinking skills, and self-control (Gobet & Campitelli, 2006). However, many educators disagree with this view because it is difficult to quantify or know exactly the expression of general intelligence (Margulies, 1991).

Chess in the Classroom

The relationship between chess and education is undeniable (Jankovic & Novak, 2019). For this reason, opportunities should be offered for students to benefit from chess practices, especially in public schools (Zirawaga et al., 2017). These practices should be increased to support education, and appropriate education plans should be prepared for all age groups. Considering that the ideal age to start chess education is four to five-years-old, it is necessary to support studies on chess education from the pre-school period and focus on studies in this field (Çubukçu & Kahraman, 2017).

Teachers' inclusion of chess in the classroom environment as an extra-curricular activity improves cognitive capacity (Keser et al., 2011). In a study conducted by Aciego et al. (2012), an improvement is seen in the cognitive competencies of students who play chess. As mentioned before, there are many advantages of chess for students. It also develops skills such as abstraction, concentration, perceptual organization, analysis, synthesis, visual coordination, planning, and foresight (Majeed et al., 2021). Moreover, Kaynar (2014) states in her study that chess education in early childhood positively affects school maturity, social skills, and attention-seeking skills. Therefore, teachers' focus on chess and playing chess more in the classroom will contribute to the personal development of the students, support the achievement of the course objectives, and make it easier to implement curriculum (Ferreira & Palhares, 2008).

Having chess education in classrooms will enable chess to reach more students. Chess can be taught as a lesson to reach a wider audience, with textbooks, test books, and chess materials (Ferguson, 1995). As an optional course, chess can be taught together with mathematics and

geometry lessons thus improving spatial intelligence and gaining the ability to solve tests and calculate faster (Rosholm et al., 2017). Chess competitions and tournaments can be organized in the school to convert free time into extracurricular activities, with online chess games, students can gain speed in the game; furthermore, chess can be used as a rehabilitation tool for students who need special education (Alifirov et al., 2018).

The positive effect of chess on academic achievement means students better understand concepts, develop memory and problem-solving skills (Kazemi et al., 2012) . Having these skills in the younger generation supports them to be more competent, controlled citizens in the future. Thus, a stronger social structure is established in the long term (Joseph et al., 2016).

Chess can also be played in the classroom for students with different characteristics. Hong and Bart (2007) emphasize the impact of chess on non-verbal intelligence, and they indicate chess education can improve the non-verbal intelligence of students who are faced with the possibility of academic failure. Similarly, chess positively affects visual memory (Charness, 1976). Individuals with low visual memory can also be good chess players (Grabner et al., 2007). Frydman and Lynn (1992) state that there is a connection between visual memory and chess. Due to this difference, it should be considered that different features of visual memory can be effective in developing chess skills (Waters et al., 2002). To reveal the relationship between chess and intelligence or visual memory more clearly, a detailed and longitudinal study should be conducted (Waters et al., 2002).

Is It Possible to Pinpoint the Influence of Chess?

Chess has long been seen as an efficient tool that can be used in the classroom (Kazemi et al., 2012). While it is an encouraging, rewarding activity for the student, it can also teach planning, concentration, discipline, and success (Mahmudov et al., 2020). However, there is an objection that chess does not have such an effect (Duella, 1982). Since the students who play chess are already smart and hardworking (McAllister et al., 2015), chess may not provide such a significant development. In addition, it is among the arguments of these opposing views that students, who already devote a lot of time to chess and focus on this skill, have little time to learn another activity; chess limits students (Duella, 1982).

In research conducted by Sala Gobet (2016), 24 studies with experimental and control groups were examined. The results show that chess is more effective in math achievement than reading skill development. However, it is stated that the ideal design was not used with pre- and post-tests in any of these studies. No study was able to assign participants fully at random (Sala & Gobet, 2016). Yet, in studies about the positive effect of chess on education, it is not enough to randomly assign students to the groups to provide the ideal experiment environment (Gobet & Campitelli, 2006). Research needs to be done in accordance with methodologies that seem deeper and perhaps more difficult (Horgan & Morgan, 1990). Structural equation modeling, for example, will provide more in-depth information than the classical experimental method (Gobet & Campitelli, 2006). With this method, the links between different variables such as reading skill and motivation, or family support and chess practice, can be determined. However, these methods may also involve a number of difficulties, such as a large sample (e.g., 700), a multitude of variables, and long research time. Another suggestion is that more detailed analysis should be made (Gobet & Campitelli, 2006; Horgan & Morgan, 1990). A link should be established between the experimental and the theoretical structure and what kinds of changes occur in the cognitive structure of the

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individual in the experimental process, which should be examined together (Gobet & Campitelli, 2006).

In Sala and Gobet's (2016) meta-analysis study, it is seen that chess teaching improves students' mathematics, reading, and cognitive skills. Yet, attention should be paid to two factors. The first one is that the average effect is .338, and below 4 indicates that the desired target was not reached. This situation reflects that more than half of the students did not achieve the desired development. In addition, this effect may be due to the efforts of the instructor who teaches chess rather than playing chess itself. This is because almost all studies do not have an active control group. It may be possible to determine the effect of chess in studies with both experimental and control groups. However, in most studies, a control group is not used (Sala & Gobet, 2016).

Similarly, Groot (1978) states that chess underperforms for increasing attention and concentration, and it does not have high-level effects such as creativity, development of intelligence, and scholastic development. In this context, the possible effects of chess are still open to question; for instance, compulsory chess training is not recommended due to motivation (Trinchero & Sala, 2016). Although chess training is effective initially, this effect decreases over time as chess skill increases; therefore, more research and a deeper understanding about the effect of chess will be needed (Gobet & Campitelli, 2006). Smith (1998) states that studies about chess may not be generalized since the participants have different qualifications as to their level of competence and adds it would not be appropriate to generalize the findings obtained in studies for novice, intermediate, and advanced players.

Another reason for the formation of controversial opinions about chess is the difficulties experienced in measuring the abstract concepts that chess affects (Horgan & Morgan, 1990). One of the reasons why the relationship between chess and concepts such as attitude, motivation, and acquisition cannot be determined precisely is that these concepts are difficult to measure (Liptrap, 1998). In the literature, there are few studies on chess knowledge and the features of the game of chess (Sala et al., 2015). As a general perception, chess depends on analytical skills, predicting different problems, and probability calculations; however, knowledge, structures of chess patterns, pieces, and templates are also important (Bilali´c et al., 2007).

As underlined by Trinchero (2013) there are three possible situations that will support experimental studies on chess: 1) chess improves people's intellectual skills; 2) people with better mental skills play better chess, become more successful, and want to play more; and 3) other factors such as motivation, alternative steps, and decision-making skills are also effective in chess (Trinchero, 2013).

Therefore, more research is recommended to explore in detail the underlying factors (Ericsson & Smith, 2011; Flyvbjerg, 2011; Van Harreveld et al., 2007). In addition to quantitative research recommendations, qualitative and mixed-method designs can be used to explore the benefits of chess instruction for students (Barrett & Fish, 2011). For instance, chess improves students' meta-cognitive skills; however, no concrete study or research supports this hypothesis. Researchers can conduct studies to determine how meta-cognitive skill improvement may be affected by playing chess.

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